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ABSTRACT

Small engines as referred to here are engines used on lawn mowers, chain saws, power plants, outboards, and cycles. It does not include engines used on automobiles. The course outlined is intended to show how small two-cycle and four-cycle gas engines are constructed, how they operate, what goes wrong, and how to service and repair them. It is also intended as a basis for those who desire to learn about automobile engines. This course is in four sections designed for a 12-week Vocational Program. It is suggested that four consecutive hours per day for 12 weeks be devoted to the program. The units are presented in single logical blocks of instruction, concluding with pertinent study questions, discussions, and demonstrations. Included are laboratory experiences which follow each of the units of study, designed to guide the student in the procedures of assembly and disassembly and direct his work in an orderly fashion. There are 28 instructional units with individual objectives and learning time. (Author/AJ)

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SMALL ENGINE REPAIR

COURSE OUTLINE

June 1971

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FORWARD

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GENERAL INTRODUCTION

Small Engines as referred to here are engines such as used on lawn mowers, chain saws, power plants, outboards, cycles and does not include engines used on automobiles. This course is intended to show how small two-cycle and four-cycle gas engines are constructed, how they operate, what goes wrong, how to service and repair them. It is also intended as a basis for those who desire to learn about automobile engines. Much of the basic information given here is applicable to automobile engines. After mastering these basics, the student interested in learning the automotive service business can then go on to the additional subjects of brakes, transmissions, wheel suspensions and other automobile units.

COURSE DESCRIPTION

The course presented is in four sections designed for a twelve-week Vocational Program. It is suggested that four consecutive hours per day for twelve weeks be devoted to the program. As total of 240 hours of instruction is involved. The units are presented in single logical blocks of instruction, concluding with pertinent study questions, discussions, and demonstrations.

Included are labratory experiences which follow each of the units of study. These are designed to guide the student in the procedures of assembly and disassembly and direct his work in an orderly fashion. These work experiences are directly correlated with the text theory and therefore are placed after those units where theory relates to them.

There are 28 instructional units with individual objectives and learning time.

OVER ALL COURSE OBJECTIVES

1. To develop skills necessary for repair and servicing of two-cycle and four-cycle gasoline engines.

2. To develop skills in the use of hand tools and equipment peculiar to the small engine repairman.

3. To develop an appreciation for good workmanship.

4. To develop acceptable work habits.

5. To develop an appreciation for the business aspect of repair shops.

6. To develop proper attitudes toward employer, fellow employees, and customers.

7. To develop an appreciation for safety procedures.

PERFORMANCE CRITERIA

To be able to perform all of the operations set forth in the objectives in a reasonable length of time which is determined by the instructor.. A combination of tests and labratory experiences are used as measuring tools.

TEACHING METHODS

The following teaching methods will be employed to achieve the desired objectives of the course:

Teaching Methods	General Classification of Activities
1. Demonstration	Operation, Safety
2. Discussion	Trade Terms and Nomenclature
3. Individualized instruction	Written instructional material

INSTRUCTIONAL AIDS

Motion pictures, slides, charts, prints and manufacturer's literature will be used whenever feasible throughout the course as a supplement to the regular material and not as a substitute.

SMALL ENGINE REPAIR TRAINING COURSE
SECTION I
INTRODUCTION TO THE COURSE,
THE OCCUPATION, AND THE INDUSTRY

Instructional Unit	Classroom hours	Lab hours	Shop hours
1. The Course.....	1	1	
2. The Occupation and the Industry.....	2		
3. Small Engine Terminology.....	3		
4. Safety and Shop Housekeeping...	1	2	
5. Use and Care of Required Hand Tools.....	2	2	6
6. Fastening Facts and Thread Identification.....	2		
Totals.....			

The first four units are designed to orient the student to the small engine repair course and to the procedures governing safety, and personal behavior in the course and the industry.

Units 5 and 6 present several essential skills to the small engine repairman.

COURSE UNITS
Unit I
The Course

Time Allocation

Classroom, hours; laboratory, hours

Unit objectives

To present an introduction to the small engine repair course.
To develop proper attitudes for this course.
To develop an understanding of the small engine repair course.
To present rules and regulations pertaining to this course.
To orient the student to the facilities.

Tools and Materials

Shop equipment, tools, supplies, and parts

Instructional Procedures

Present the objectives and content of the course by lecture and discussion. Relate the items presented to equipment and procedures. Tout the physical facilities.

Unit Outline

A. Objectives of this course

1. To develop skills necessary for repair and servicing of two-cycle and four-cycle gasoline engines

2. To develop skills in the use of hand tools and equipment peculiar to the small engine repairman

3. To develop an appreciation for good workmanship

4. To develop acceptable workhabits

5. To develop an appreciation for safety procedures

6. To develop an appreciation for the business aspect of repair shops

7. To develop proper attitudes toward employer, fellow employees, and customers

B. The scope of the small engine repair course

1. Introduction to small engine repair course

a. Orientation to the course

b. Introduction to small engines

c. Small engine terminology

d. Safety and shop housekeeping

e. Use and care of required hand tools

f. Fastening facts and thread identification

2. Four-stroke cycle engines

a. Engine principles

b. Review of safety factors

c. Use and care of shop equipment

d. Lubrication

e. Proper use of manufacturer's specifications, manuals, catalogs, and price lists

f. Ignition and starter systems

g. Carburation and fuel systems

2. Four-stroke cycle engines (continued)

h. Engine speed control (governor and Linkage adjustment)

i. Engine cooling

j. Tune-up techniques

k. Troubleshooting techniques

l. Major engine overhaul

m. Multiple cylinder engine overhaul

n. Proper gear, belt, and pulley application

3. Two-stroke cycle engines.

a. Engines principles

b. Lubrication

c. Ignition and recoil starter systems

d. Carburation and fuel systems

e. Engine speed control (governor and linkage adjustment)

f. Engine cooling (including marine engines)

g. Tune-up techniques

h. Troubleshooting techniques

i. Major engine overhaul

j. Routine maintenance and storage

4. Business procedures

a. Business procedures

b. Customer relations

C. Orientation to facilities

1. Classroom

2. Shop area

3. Tool room

4. Equipment

C. Orientation to facilities (continued)

5. Cleaning area

6. First aid equipment

7. Fire fighting equipment

D. Rules and regulations

1. Personal safety

a. No rings or watches when working on projects

b. Shirts tucked in

c. Use of safety glasses

d. No sharp tools in pockets

2. Attendance

3. Use and care of equipment and tools

a. After instruction

b. Safety procedures

c. Proper storage

4. Use of tool room and storeroom

a. Tool check out procedures

b. Proper storage of tools

c. Proper storage of equipment

d. Storage of oily rags

e. Storage of gasoline and solvents

5. Assignments

a. Shop jobs

b. Reading assignment

c. Assignment sheets

d. Use of progress charts

e. Types of tests

f. Standards for the course

6. Cleanup Assignments

   a. Work areas

   b. Shop floor

   c.. Tool room

   d. Storeroom

   e. Oily rag disposal

7. Rules and regulations which apply to a particular school

Laboratory Activity

Tour of facilities

Tsxts and References

Automotive Electrical Association. The Economic Facts of Life for the Small Engine Service Dealer. Various manufacturers' literature.

UNIT 2
The Occupation and the Industry

Time Allocation

Classroom, 2 hours

Unit Objectives

To develop an appreciation for the varied uses of the small engine

To learn of the need for small engine repairmen

To develop an understanding of the problems of the small engine industry

Tools and Materials

Several representative small engines

Instructional Procedure

Present the needs for and uses of small engines and the requirements for small engine repairmen by lecture and discussion. Have representative small engines on display for students to examine.

Unit Outline

A. Uses of small engines

1. Lawn mowers
2. Garden tractors
3. Chains saws
4. Pumps
5. Portable power equipment
6. Leaf blowers
7. Lawn and driveway sweepers
8. Industrial uses
9. Post hole augers
10. Rail spike hammers
11. Agricultural uses
12. Portable generators
13. Boats
14. Toy autos
15. Conveyors
16. Concrete mixers
17. Self-contained water ski units
18. Snow blowers
19. Power sleds
20. Go carts
21. Rototillers

B. Need for small engine repairmen

1. Past and projected sales record of lawn mowers

1950--1,000,000

1958--3,000,000

Need for small engine repairmen (continued)

1962--4,000,000

1965--estimated 6,000,000

1970--projected 7,900,000

2. Population increase of 20% over the next few years to bring a corresponding increased use of small engines.

3. Small engine servicing

a. Eventually needed by all engines

b. Shipping costs to factory against cost of repair

c. Purchase of service with engine by customer

d. Routine owner maintenance

e. Complete repair service

f. Tune-up service

4. Small engine service facilities

a. Regular auto garages

b. Small engine service center

c. Factory repair service

d. Service station

e. Department store service center

f. Private individuals

g. Wholesale outlets

h. Automotive parts jobbers

C. History of the small engine

1. Started about 1900

2. Became popular during World War II

D. The small engine repairman

1. Interest in mechanics

2. A good problem solver

D. The small engine repairman (continued)

3. Personal qualities

a. Thorough in work

b. Pleasant personality

c. Ability to understand written instructions

d. Ability to apply math to the trade

e. Sales ability

f. Ability to express thoughts orally and in writing

g. Cooperative

h. Ability to follow instructions

i. Curiosity

j. Imagination

k. Loyalty to employer

l. Neat appearance

4. Future for small engine repairmen

a. Anticipated growth in small engine usage

b. Shortage of qualified small engine repairmen

c. Financial future of the small engine repairman

E. Industry problems

1. Shortage of repairmen

2. Shortage of service centers

3. Difficulty in stocking parts

4. Estimated 13,000,000 units in need of repair

5. Anticipated increase in service requirements

6. The demand for good service resulting from increased competition

7. Sales ahead of service

8. Lack of training facilities for small engine mechanics

Texts and References

Automotive Electrical Association. The Economic Facts of Life for the Small Engine Service Dealer. Manufacturers' literature.

Unit 3
Small Engine Terminology

Time Allocation

Classroom, 3 hours

Unit Objectives

To present the terminology of small engine repair

To develop an appreciation for the complexity of the small engine repair field

Tools and Materials

Textbook containing terms

Instructional Procedure

Assign a list of terms (including definitions) for the student to study prior to this presentation. Review the terms during the required number of lecture periods. The students should not be required to memorize the terms. The instructor should comment on each term based on his experience. The terms will be used during the course of instruction.

Unit Outline

A. Value of standard definitions

   1. Communication

   2. Ordering parts

B. Terms common to the small engine industry.

   1. Additive

   2. Air cleaner

   3. Air fuel ratio

   4. Air gap

   5. Air horn

   6. Alternator

B. Terms common to the small engine industry (continued)

7. Anti-clockwise rotation
8. Atmospheric pressure
9. Atomize
10. Backfire
11. Backlash
12. Backpressure
13. B.H.P. brake horse power
14. Before-dead-center
15. Blow-by
16. Bore (cylinder)
17. Boring bar
18. Boss
19. Breaker arm
20. Breaker point
21. Break-in
22. Burnish
23. Bushing
24. By-pass
25. Calibrate
26. Cam
27. Cam angle
28. Cam ground piston
29. Cam shaft
30. Carbon
31. Carburetor
38. Compression ratio
39. Condenser
40. Connecting rod
41. Counterbore
42. Counterweight
43. Crankshaft
44. Cycle
45. Cylinder block
46. Cylinder head
47. Cylinder sleeve
48. Dead center
49. Detonation
50. Diaphragm
51. Die
52. Direct drive
53. Displacement
54. Dog clutch
55. Dowell pins
56. Down-draft

Terms common to the small engine industry (continued)

32. Centrifugal force
33. Chamfer
34. Choke
35. Clutch
36. Combustion
37. Compression
38. Compression ratio
64. Filter
65. Fin
66. Float
67. Floating piston pin
68. Float level
69. Flutter or bounce
70. Flywheel
71. Foot pound
72. Four-cycle engine
73. Gasket
74. Gear
75. Gear ratio
76. Generator
77. Glaze breaker
78. Governor
79. Growler
80. High-test gasoline
81. Hone
82. Horsepower
57. Dreve fit
58. Dwell
59. Dynomometer
60. Eccentric
61. End play
62. Engine displacement
63. Feeler gauge
90. Knurl
91. Lands
92. Lap
93. Liner
94. Linkage
95. Load
96. Lost motion
97. Magneto
98. Mesh
99. Micrometer
100. Miss
101. Mono-block
102. Muffler
103. Nozzle
104. Octane number
105. Oil pumping
106. Orifice
107. Out of round
108. Outside diameter

Terms common to the small engine industry (continued)

83. Idle
84. Ignition
85. Internal combustion
86. Jet
87. Journal
88. Key-keyway
89. Knock
109. Overhead valve or valve-in-head
110. Pawl
111. Phillips screw or screwdriver
112. Piston
113. Piston collapse
114. Piston pin
115. Piston ring
116. Piston ring compressor
117. Piston ring gap
118. Pitted
119. Poppet valve
120. Port
121. Preignition
122. Preloading
123. Press fit
124. Race
125. Ratio
126. Resistance
127. Retard
128. Ridge
129. Ring gap
130. Ring gear
131. Rotary valve
132. SAE
133. SAE thread
145. Spark advance
146. Spark gap
147. Spark plug
148. Spline
149. Standard thread
150. Stroke
151. Stud
152. Tachometer
153. Tappet
154. Throw
155. Thrust
156. Timing gears
157. Tolerance
158. Top-dead-center
159. Torque
160. Torque wrench

Terms common to the small engine industry (continued)

134. SAYBOLT TEST
135. Scoring
136. Seat
137. Seizing
138. Shear
139. Shim
140. Shrink-fit
141. Skirt
142. Sleeve
143. Sludge
144. Solvent
161. Troubleshooting
162. Tune-up
163. Two-cycle-engine
164. Vacuum
165. Valve
166. Valve clearance
167. Vanes
168. Venturi
169. Volumetric efficiency
170. Work
171. Wrist pin

Texts and References

Automotive Electrical Association..A.E.A. Air Cooled Engine Manual
Purvis, Jud. All About Small Gas Engines.

Unit 4
Safety and Shop Housekeeping

Time Allocation

Classroom, 1 hours; Laboratory, 2 hours

Unit Objectives

To develop an appreciation for good safety habits

To present to the student good housekeeping procedures

To relate good housekeeping to good safety practices

To demonstrate how accidents happen

To discuss why accidents happen.

Tools and Materials

Safety glasses

Shop equipment

Tools and Materials (continued)

Tools

Several representative engines

Instructural Procedure

Present by lectures, discussion, demonstration, and films good safety procedures and housekeeping procedures. Assign students to shop cleanup duties on a rotation basis. Introduce the students to safety practices and devices during the course of the presentation.

Unit Outline

A. Safety and the small engine repairman

1. Personal safety
    a. Safety glasses
    b. No long hair
    c. Proper clothing
        (1) Shirt tucked in
        (2) Shirt cuff buttoned
        (3) No jewelry
        (4) Clean clothing
        (5) Proper shoes
        (6) No long tie
2. Financial loss due to accident
    a. Loss of wages and possible loss of employment
    b. Loss of income to employer
    c. Loss of service to customer
    d. Chance of permanent disability

B. Shop safety

1. Entrance and exit locations
2. Operation of exhaust system
3. Gasoline and oil storage

B. Shop safety (continued)

4. Waste rag disposal

5. Use of fire extinguisher

6. Clean floors

a. Oil spillage

b. Removal of tools, equipment, etc.

7. Procedure in event of fire

a. First aid equipment

b. Telephone procedures in event of injury

8. Danger areas

C. Shop equipment safety

1. Use of electrical equipment

a. Check cords

b. Proper grounding

c. Grounded outlet

2. Grinding type equipment

a. Use of shield and safety glasses

b. Safety guards and tool rests

3. Hand tools

a. Correct tool for job

b. Correct use of tool

c. Storage of tools

D. Safety while performing job; proper mounting of engine before starting

1. Proper bench

2. Proper installation of equipment

E. Good shop housekeeping; assignment to daily cleanup job

1. Working areas

E. Good shop housekeeping; assignment to daily cleanup job (continued)

2. Tool room

3.. Floor

4. Equipment

5. Storage of current jobs

6. Storage of extra supplies and equipment

7. Proper care of equipment

8. Parts cleaning area

F. Good shop habits

1. Walk - don't run

2. Observe conditions

a. Slippery floors

b. Debris on floor

3. Look before you act

4. Keep proper balance when lifting

5. Keep electric cords out of traffic areas

6. Use absorbents properly

G. Safety and this course

1. Safety will be stressed in all activities

2. When in doubt, ask your instructor

Laboratory Activity

Inform all students of all the jobs within a small engine repair shop that require eye protection (glasses or shields). Show how a moving part will catch a cloth or hair by placing cloth in the appropriate moving part. Tout physical facilities with objective of emphasizing safety. Have the local fire department demonstrate proper extinguishers for fuel and electrical fires.

Texts and References

Williams, William A.. Accident Prevention Manual for Shop Teachers

Unit 5
Use and Care of Required Hand Tools

Time Allocation

Classroom, 2 hours; laboratory, 2 hours; shop, 6 hours

Unit Objectives

To orient the students to proper care and use of hand tools and skills related to their use in the small engine repair field

To develop the correct attitude concerning careful storage and maintenance of hand tools

Tools and Materials

Student tool kit

Bearing drivers

Reamers (adjustable)

Oil seal loaders

Oil seal pullers and drivers

Micrometer and rulers

Drill index

Valve spring compressor

Hand valve seat cutter

Valve seat cutter for over size valve seats

Spanner wrenches, pullers

Piston ring compressors

Worn engines for practice

Instructional Procedure

Present material by lecture, discussion, demonstration, audio-visual aids, and student shop participation.

Unit Outline

A. Small engine mechanic's tools for discussion

1. Box and wrenches

A. Small engine mechanic's tools for discussion (continued)

a. Where used

b. Advantages of box end wrenches

2. 3/8" drive socket set

a. Advantages

b. Types ofmaterial used in makeup

c. Adaptors for 3/8" drive set

3. Ignition tool kit

a. Complete explanation of use

b. Safety in use

4. Allen wrench set

a. Where used

b. Advantages

5.. Pliers

a. Needle nose

b. Diagonal cutting

c. Adjustable

d. Vise grip

6. Screwdrivers

a. Two standard sizes

b.. Phillips head

c. Offset

d. Screw holding type

e. Magnetic

f. Clutch type

A. Small engine mechanic's tools for discussion (continued)

7. Spark plug sockets

a. Three sizes

(1) 5/8 "

(2) 13/16 "

(3) 7/8 "

b. Purpose

c.. Careful use during removal of spark plug from engine

8. Punches

a. Center

b. Pin

c. $\frac{1}{2}$ drift soft brass

9. Hammers

a. Ball peen (small size)

b. Lead

c. Plastic

10. Files

a. Point

b. Mill

c. Ground

11. Open and wrenches

a. 5/16 "

b. 3/8 "

c. 7/16 "

d. 1/2 "

e.. 9/16 "

f. 5/8 "

A. Small engine mechanic's tools for discussion (continued)

12. Adjustable wrenches

a. Proper use

b. 6" and 8" adjustable

B.. Related shop discussion topics

1. Shop safety in using hand tools

2. Making tools

3. Using tools with correct handles

4. Keep tools with correct handles

5. Do not overtax tool beyond capacity

6. Protective glasses in the shop or laboratory when using small reamers, cutters, etc.

7. Proper tool usage

C. Demonstration during laboratory. (Should consist of hand tool demonstration along with a thorough operational demonstration of special shop tools such as the following.)

1. Vises

a. Standard

b. Vise fixtures

2. Drills

a. Hand $\frac{1}{4}$ "

b. Press drill

c. Drill bits

3.. Taps and dies

a. Drill gauge

b. Lubricants for cutting threads

4. Valve lifter

5.. Piston ring expander

6.. Piston ring compressor

C. Demonstration during laboratory (continued)

7. Valve seat cutter

8. Various pullers

9. Reamers (adjustable)

10. Micrometers

A. Inside

b. Outside

11. Cylinder dial gauge

Laboratory activity

Instructor should name each tool in the student's kit and demonstrate its correct use and maintenance. All shop specialty tools should be presented in the laboratory. Representatives of tool manufacturers can be enlisted to assist in the presentation of the use of special tools required for small engine servicing.

Shop Activity

Students should be given an opportunity to inspect all their tools and be given small projects in which to acquaint themselves with their tools on a particular shop job, such as disassembly of some short block assemblies.

Drill gauges can be made along with other timesaving devices for small engine work.

Texts and References

Delmar Publishing Co., General Repair Tools

General Motors, Inc. ABC's of Hand Tools

Unit 6
Fastening Facts and Thread Identification

Time Allocation

Classroom, 2 hours

Unit Objectives

To give the student sufficient knowledge to select the proper fastener for a job on small engines

To orient the student to new fasteners

Tools and Materials

Assortment of bolts, nuts, and screws

Instant clamp fasteners

Wire coils for replacement threads

Instructional Procedure

Present by lecture and classroom discussion material on various nuts,and bolts and their uses. Relate their use to small engine repair.

Unit Outline

A. Importance of good fasteners

1. Save down time

2. Save on the life of the engine

B. Different methods of fastener manufaclure

1. Cut threads

2. Rolled threads

C. Fine vs. coarse threads

1. National fine or SAE

a. Used where taper breakage is no problem

b. Greater resistance to stripping where thread engagement is short

c. Sensitive tightening adjustment

d. Resistance to loosening under vibration

e. Develops greater strength in static assemblies

2. National Coarse or USS

a. Greater depth

b.. Less affected by nut expansion

F. Screws (continued)

c. Not sensitive to burrs and nicks in handling

d. Less liable to grab or seize when reused in service

D. Proper nomenclature of threads

1. Lead

2. Pitch

3.. Thread

4. Selective thread

E. Proper identification and use of bolts

1. Machine bolts

2. Stove bolts

3.. Carriage bolts

4. Stud bolts

F. Screws

1. Set screws

a. Square heads

b. Headless types (on moving parts where operator could become entangled)

c. National coarse threads

d. Fastens collars

e. Pulleys on shafts

2. Self-tapping screws

a. Makes own thread

b. Straight screwdriver slots

c. Phillips

d. Made of hardened steel

e. Coated or uncoated

3. Drive screws

a. Permanent fastenings

b. Withstands stresses and vibrations

G. Nuts, shapes and sizes

1. Size of nut determined by size of bolt

2. Jam nuts

3. Pal nuts

4. Castle nuts

5. Wing nuts

H. Washers

1. Form bearing surface under nuts

a. Made from carbon steel

b. Hardened and tempered

2. Flat washer

3. Spring lock washer

4. Internal shakeproof

5, External shakeproof

I. Pin keys; cotter keys

1. Sizes

2. Where used in small engines

3. How installed

4. Proper removal

J. Keys; variety of shapes

1. Woodruff

2. Square

3. Giv

K. Lock rings

1. Hold parts together

   a. Materials used for lock rings

   b. Tools required to remove and replace lock rings

2. Complete circle rings

3. E-type ring

4. Crescent ring

5. Grip ring

6. External circular self-locking ring

7. Basic internal type

Texts and References

Bowman Products Co. General Repair Tools for Automotive Mechanics.

Long, Kenneth F. Outboard Motor Service Manual.

SECTION II

FOUR-STROKE CYCLE ENGINES

Instructional Unit	Instruction Time		
	Classroom Hours	Laboratory Hours	Shop Hours
1. Engine Principles.....	7	2	6
2. Use and Care of Shop Equipment...	1	-	1
3. Lubrication.....	2	1	2
4., Proper Use of Manufacturers' Specifications, Manuals, Catalogs, and Price Lists.....	2	-	2
5.. Ignition and Starter Systems.....	2	1	5
6. Carburetion and Fuel Systems.....	4	2	7
7. Engins Speed Controls (Governors and Linkage Adjustments).....	1	1	1
8. Engine Cooling.....	1	1	1
9. Tune-up Techniques.....	7	3	6
10. Troubleshooting Techniques.....	2	2	10
Totals.....			

The purpose of Section II is to present proper procedures for repair of four-stroke cycle engines. Unit I serves to present an overview of the components of a four-stroke cycle engine Units 3, 5, 6, 7, and 8, present details of major components of a four-stroke cycle engine. Unit 4 emphasizes the value of Manufactures' publications and present directions in the use of Manufacturers' literature. Units 9 and 10, involve the student in situations he will encounter in the repair shop. Safety must be stressed as appropriate in each unit.

COURSE UNITS

Unit I

Engine Principles

Time Allocation

Classroom, hours; laboratory, hours; shop, hours

Unit Objectives

To develop an understanding of the principles of the four-stroke cycle engine.

To develop a knowledge of the components of the four-stroke cycle engine.

Tools and Materials

Student tool kit

Representative makes of four-stroke cycle engines

Instructional Procedure

Present the basic principles of the four-stroke cycle engine by lecture, discussion, reading assignments, and audio-visual aids. These principles should be presented in conjunction with the laboratory demonstrations and shop assignments on four-stroke cycle engines as indicated in the outline.

Unit Outline

A. Four-stroke cycle - principles of operation

1. Intake stroke
2. Compression stroke
3. Power stroke
4. Exhaust stroke

B. Piston movement

C. Valve movement

1. Valves
2. Valve train
3. Valve timing

D. Piston displacement

1. Explanation
2. Determining displacement

E. Compression ratios

F. Arrangement of cylinders

1. Vertical cylinders
2. Horizontal Cylinders
3. Opposed type cylinders
4. V-type cylinders

C. Engine cylinders

1. One-piece cylinders
   a. Advantages and disadvantages
   b. How cast
2. Two-piece cylinders
   a. Advantages and disadvantages
   b. How cast
3. Cast iron cylinders
   a. Advantages and disadvantages
   b. How cast
4. Aluminum cylinders
   a. Advantages and disadvantages
   b. How cast
5. Clyinder block warpage
   a. Cause
   b. Prevention
6. Cylinder wall wear
7. Cylinder heads

H. Engine crankshafts

1. Purpose of crankshaft
2. Main bearingjournals
3. Connecting rod journals
4. Materials used for crankshaft

H. Engine crankshafts (continued)

5. Balancing of crankshafts

a. Static balance

b. Dynamic balance

6. Crankshaft alignment

7. Crankshaft taper and out of round

I. Engine camshafts

1. Purpose of camshaft

2. Parts of a cam

3. Lobes on camshaft

4. Camshaft alignment

J. Engine bearings

1. Purpose of bearings

2. Types of bearings

a. Integral

(1) How manufactured

(2) Materials used in manufacture

b. Precision bearings

(1) How manufactured

(2) Materials used in manufacture

c. Needle bearings

(1) How manufactured

(2) Materials used in manufacture

3. Bearing clearances

a. Methods of determining bearing clearances

(1) Plastic ribbon method

(2) Shim stock method

(3) Colored shim method

(4) Micrometers

b. Thrust clearances

(1) Checking with feeler gauge

(2) Checking with dial gauge

4. Bearing replacement

a. Procedure

b. Precautions

5. Bearing adjustment of integral bearings

a. Removal of shims

b. Filing the cap

6. Camshaft bearings

a. Types used

b. Replacement

7. Bearing failure

a. Improper lubrication

b. Improper adjustment

c. Misalignment

d. Abrasives

K. Piston rings

1. Purpose

2. Types

a. Compression rings

b. Oil rings

c. Ring gap design

3. Materials

4. Piston ring gap in cylinder

5. Ring groove clearance

L. Pistons

1. Piston materials

2. Piston construction

3. Piston design

a. T slot

b. U slot

c. Solid design

d. Strut design

e. Steel belted type

f. Cam ground pistons

4. Piston clearance

a. Knurling of pistons

b. Piston expanders

M. Piston pins

1. Purpose

2. Types

a. Full floating

b. Anchored to piston

c. Clamped in rod

3. Materials used in manufacture

N. Valves

1. Types
2. Parts
3. Cooling
4. Seats
5. Stem guides
6. Springs
7. Timing
8. Adjustments
9. Stem seals

Laboratory Activity

The instructor will disassemble the short block of a four-stroke cycle engine and identify all components. The students should be given the opportunity to handle and examine all basic parts.

Shop Activity

It is suggested that several different makes of worn engines be used for shop activity, giving each student a chance to check different makes of engines for worn parts as they actually occur in the field.

1. Disassemble short block assembly.
2. Examine crankshaft journals
3. Measure crankshafts and journals for taper and out or round and undersize
4. Examine valve guides, valve seats, and valve assemblies for excessive wear, distortion, looseness, and seat contact.
5. Examine valve springs and test for loss of tension
6. Examine camshaft and measure lobes
7. Identify timing marks on crankshaft gear and timing gear
8. Examine bearings for wear, pits, and scratches.

Shop Activity (continued)

9. Measure bearing clearances using plastic ribbon
10. Measure bearing clearances using shim stock
11. Check connecting rod alignment
12. Check out of round connecting rods
13. Examine piston pins for wear, locks and clearances
14. Measure piston for size, score, and wear
15. Check piston for cracks, worn grooves, and worn lands
16. Check piston clearance with a feeler ribbon and spring scale.
17. Check for worn rings, ring gap, and groove clearance of rings

Texts and References

Automotive Electrical Association. Principles of Operation,
Service Maintenance Air Cooled Engines
Long, Kenneth F. Small Engines Service Manual
Stevenson, George E., Small Gasoline Engines

Unit 2
Use and Care of Shop Equipment

Time Allocation

Classroom, hours; shop, hours

Unit Objective

To develop skills in the use and care of shop equipment

Tools and Materials

Wheel and gear pullers
Testing equipment
Bench grinders
Electric drills
Tool racks
Valve equipment
Torque wrench
Micrometer
Telescoping gauge
Reamer

Tools and Materials (continued)

Carburetor gauge
Feeler gauge
Oil seal driver and puller
Piston ring expanders and compressors
Cylinder hones

Instructional Procedure

Present the proper usage and care of shop equipment and tools by lecture, discussion, and audio-visual aids.

Unit Outline

A. Types of pullers

1. Sliding hammer adapted to puller
2. Multijaw puller
3. Flywheel puller

B. Types of testing equipment

1. Coil tester
2. Consenser tester
3. Spark tester
4. Tachometer
5. Spark plug tester

C. Torque wrenches

1. How to handle
2. How to read correctly in inch- or foot-pounds
3. Special adaptors

D. Carburetor gauges

E. Valve equipment

1. Valve refacer
2. Hard seat grinder
3. Valve guide drivers

Valve equipment (continued)

4. Valve guide cleaners

5. Bearing glue

6. Spring tension gauge

7. Valve seat replacement tools

8. Suction cup and compound

F. Micrometer

1. Inside

2. Outside

G. Telescoping gauges

H. Piston ring expanders and compressors

I. Cylinder hones

J. Feeler gauges

K. Oil seal pullers and drivers

L. Reamers

1. Roughing

2. Finishing

3. Valve guide reamers

Shop Activity

It is suggested that each student be allowed to use and care for the different types of tools used on four-stroke cycle engines.

1. Remove a flywheel using special pullers
2. Test several coils and condensers using test equipment
3. Torque several heads on the small engines using the inch- and foot-pound wrenches
4. Remove carburetors and check and adjust float level
5. Grind valves using valve equipment
6. Measure bearing journals and cylinders using micrometers and telescoping gauges
7. Remove and replace rings on pistons using the ring expander
8. Use a ring compressor and install a set of rings and a piston assembly into the cylinder

Shop Activity (continued)

9. Adjust valves using the feeler gauge to check clearance
10. Remove and replace crankshaft oil seals
11. Ream out several bushings using the roughing reamer first and then using the finishing reamer to complete the operation.

Texts and References

Briggs & Stratton, Repair Instructions II
Clinton Engines Corp. Clinton Field Service Manual
Purvis, Jud. All About Small Gas Engines
Tecumseh Products Co. Mechanics Handbook
Appropriate manufacturers' manuals

Unit 3
LUBRICATION

Time Allocation

Classroom, hours; laboratory, hours; shop, hours

Unit Objective

To develop an understanding of the lubrication systems found in four-stroke cycle engines

Tools and Materials

Student tool kit
Representative makes of engine oil systems and pumps

Instructional Procedure

Present by lecture, discussion, and visual aids the types of lubrication systems and types of oil pumps used.

Unit Outline

A. Purpose of lubricating oils

1. Cooling actions
2. Cleaning actions
3. Sealing action
4. Lubrication action

Unit Outline (continued)

B. Types of lubricating oils to use

1. Detergent oil

2. Nondetergent oil

3. Oil S.A.E. ratings recommended

C. Oil slingers for aluminum engines

1. New styles

2. Old styles

3. How driven

D. Oil dippers - aluminum and cast iron engines

1. How operated

2. Proper installation on rod

E. Oil slingers for cast iron engines

1. How operated

2. Measuring clearances

3. End play specifications

F. Idler gears

1. End play specifications

2. How end play is adjusted

G. Oil pumps

1. Types used

2. Overhaul procedures

3. Installing oil pumps in engines

4. Testing pumps for operation

Laboratory Activity

The instructor will show the various types and designs of oil pumps, dippers, and slingers

Shop Activity

It is suggested that several engines of various types and designs be used to examine and test types of lubrication systems used.

1. Remove the lower case
2. Examine the oiling system
3. Note markings on pumps
4. Note position of dippers used
5. Remove idler gear and check idler gear end play
6. Prime and oil pump
7. Install an oil pump
8. Check an oil pump for operation

Texts and references

Briggs & Stratton, Repair Instructions II
Clinton Engines Corp. 1965 Clinton Field Service Clinic Manual
Purvis, Jud. All About Small Gas Engines
Stephenson, George E. Small Gasoline Engines
Tecumseh Products Co. Mechanics Handbook
Appropriate manufacturers' manuals.

Unit 4

Proper Use of Manufacturers' Specifications Manuals, Catalogs, and Price Lists

Time Allocation

Classroom, hours; shop, hours

Unit Objectives

To develop proper knowledge and skills in the ordering and pricing of parts through the use of manufacturers' specifications, manuals, and parts catalogs

Tools and Materials

Several makes of four-stroke cycle engines
Manufacturers' manuals
Manufacturers' parts catalogs
Manufacturers' parts price lists

Instructional Procedure

Present to the student the proper methods of locating engine specifications and of pricing parts through reading and understanding manuals and parts catalogs. Select examples of parts that have foot-notes in the catalogs.

Unit Outline

A. Manufacturers' engine nameplate

1. Model numbers
2. Serial numbers
3. Type of engine
4. Types of crankshafts
5. Types of starter systems used
6. Types of bearings used
7.. Types of auxiliary power takeoff and speed reducers
8. Major design changes
9. Model variations

B. Manufacturers's specifications

1. Clearance of engine parts
2. Torque specifications of bolts

C. Parts Catalogs

1. Proper part nomenclature
2. Part numbers
3. Model numbers
4. Parts interchangeability
5. New parts listings

D. Price sheets

1. Comparing part numbers and pricing
2. Learning prices
3. Learning discounts

Shop Activity

It is suggested that students use engine blocks with manufacturers' data plates attached. Assign each student several engines to use for information.

1. Determine the following data from nameplate:

Shop Activity (continued)

Make of engine
Model number
Serial number
Type of engine
Type of crankshaft
Type of starter systems
Type of bearings
Type of auxiliary power takeoff and speed reducer
Major design changes
Modes variations

2. Determine manufacturers' specifications for clearances of engine parts.

3. Use parts catalogs

Select several parts for replacement
Look up part numbers
Look up prices of parts

Texts and References

Briggs & Stratton. Repair Instructions II
Briggs & Stratton. Parts Manual
Clinton Engines Corp. Parts Manual
Clinton Engines Corp. 1965 Clinton Field Service Clinic Manual
Long, Kenneth F. Small Engines Service Manual
Appropriate manufacturers' manuals

Unit 5

Ignition and Starter Systems

Time Allocation

Classroom, hours; laboratory, hours; shop, hours

Unit Objectives

To develop an understanding of the ignition and starter systems for the four-stroke cycle engines

Tools and Materials

Student tool kit
Set of ignition points
Cam for breaker points
Spark plugs of various types and heat range
Condenser
Flywheel magnet
Coil

Instructional Procedures

Present the basic principles of ignition and starting systems by lecture, discussion, reading assignments, and visual aids.

Unit Outline

A. Function of the ignition circuit

1. Primary circuits
2. Secondary circuits

B. Molecules

1. Atoms
2. Protons
3. Electrons

C. Ohm's Law

1. Amperes
2. Ohms
3. Voltage

D. Types of circuits

1. Series
2. Parallel
3. Series parallel

E. Magnetism

1. Electromagnetism
2. Permament magnets

F. Breaker points

1. Types
2. Point gap adjustment
3. Point spring tension
4. Point alignment
5. Ignition timing

C. Spark Plug

1. Gap
2. Heat range
3. Reach
4. Various sizes

H. Condensers

1. How connected in the circuit
2. Purpose of condensers
3. Testing of condensers

I. Coils

1. Primary windings
2. Secondary windings
3. Testing of coils

J. Magnetos

1. Low tension
2. 2. High tension
3. Rotary inductor
4. Rotating magnet
5. Flywheel magnetos

K. Starting systems

1. Easy spring starters
2. Rewind starters
3. Electric starters
4. Impulse starters

Laboratory Activity

The instructor will disassemble an ignition system and identify all components. The student should examine all parts.

Shop Activity

Several types of magento ignition systems should be used.

1. Remove flywheel
2. Inspect points, condenser, and coil
3. Test coils for opens, grounds, and shorts
4. Check "E" gap
5. Recharge magnets
6. Test condenser for resistance, capacity, and insulation breakdown
7. Adjust ignition point tension and alignment
8. Test ignition point tension and alignment
9. Install flywheel lineup key
10. Test ignition contacts for resistance
11. Test spark with spark tester
12. Remove spring rewind starter
13. Rewind starter spring
14. Install starter on engine
15. Test starter for operation

Texts and References

Briggs & Stratton. Repair Instructions II
Briggs & Stratton. General Theories of Operation
Purvis, Jud. All About Small Gas Engines
Stevenson, George E. Small Gasoline Engines
Clinton Engines Corp. 1965 Clinton Field Service Clinic Manual
Long, Kenneth F. Small Engines Service Manual
Tecumseh Products Co. Mechanics Handbook

Teaching Aids

Briggs & Stratton. Slide Set No 17, Condensers and Points
Briggs & Stratton. Slide Set No. 21, New Improved Ignition Systems
Briggs & Stratton. Slide Set No. 16, Easy Spin Starting
Briggs & Stratton. Slide Set No. 10, Shock Free Wind Up Starter
Briggs & Stratton. Slide Set No. 25, Sealed Starter Clutch
Tecumseh Products. Slide Set No. 690141, 2-cycle Engines

Unit 6

Carburetion and Fuel Systems

Time Allocation

Classroom, hours; laboratory, hours; shop, hours

Unit Objective

To acquaint the student with the various types of fuel systems, component parts, and proper testing and actual installation (The fuel system of a small four-stroke cycle engine includes the tank, fuel lines, fuel pump, filters, carburetor, and Manifold and air cleaner.)

Tools and Materials

Student tool kit
Fuel pump tester
Various carburetors
Fuel pumps
Fuel lines and fittings

Instructional Procedure

Present material by lecture and discussion method, and use shop participation. Discuss small engine carburetion. Use audio-vis visual aids on carburetors, pumps and filters. Laboratory work should consist of instructor showing proper methods of fuel systems repair. Shop work should consist of repair and installation of fuel system components.

Unit Outline

A. Fuel filter service

1. In line filters
2. Ceramic filters
3. Bronze filters
4. R & R filters

B. Air cleaner service

1. Dry type
2. Metal cartridge
3. Wet type
4. Oil type
5. Oil foam or spill type air cleaner

C. Carburetion

1. Purpose
2. Atmospheric pressure
3. Venturi
4. Air foil
5. Main adjustments

D. Gravity feed carburetors

1. Tank location
2. Vented tank
3. Float level adjustments
4. Throttle plate positions
5. Idle valve adjustments
6. Choke circuit adjustments
7. High speed adjustment

E. Suction feed carburetors

1. No idle valve
2. Choke sliding plate
3. Must be adjusted carefully

F. Diaphragm-type carburetors or aircraft type

1. Function
2. Constant air fuel ratio
3. Separate fuel supply
4. 360 degrees mounting
5. Multispeed adjustments
6. Built-in fuel pump
7. Most widely used carburetor on today's small engine
8. Tachometer should be used when adjusting carburetor idle speeds

G. Carburetor areas of trouble

1. Vapor lock
2. Carburetor icing
3. Flooding
4. Over-rich mixture
5. Lean mixture
6. Restricted air cleaner
7. Intake air leaks

H. Fuel pumps

1. Operating principles
2. Parts
3. Testing procedures
4. Repair

Laboratory Activity

Cut away used filter and show dirt. Instructor should trace flow of fuel and acquaint students with all the parts of the fuel system. Instructor should demonstrate how to make the proper carburetor adjustments with engine running.

Shop Activity

Service air cleaners of engines that have been in use. Select engines with various types of air cleaners. Carburetors should be dismantled very carefully during overhaul. Carburetor servicing primarily consists of cleaning, inspection, and adjustment, so this work should be done on all three main types of carburetors from running engines. A few important facts to consider during carburetor overhauling in the shop:

1. A carburetor has one job to perform - to mix fuel and air and transfer it to the combustion chamber
2. There are three areas for malfunction: mixture too lean, mixture too rich, or mixture leaks
3. Operation is hampered by foreign material, solid or liquid
4. Proper carburetor overhaul consists of restoring the carburetor to its original condition
5. More carburetors are ruined by neglect and abuse than by operating damage.

Shop Activity (continued)

6. Carburetor manufacturers and jobbers are a source for obtaining gaskets and overhaul kits. Since gaskets wear out from continuous use, a supply should be maintained
7. In carburetor overhaul, the engine and ignition system must be in good condition

Texts and References

Briggs & Stratton. Form MS 3553-24
Clinton Engines Corp. 1965 Clinton Field Service Clinic Manual
Long, Kenneth F. Small Engines Service Manual
Stephenson, George E. Small Gasoline Engines.

Teaching Aids

Pulse Jet Carburetors. Briggs & Stratton
Checking Carburetors. Briggs and Stratton
Wall Chart #6910102. Tecumseh Products Co.

Unit 7

Engine Speed Controls (Governors and Linkage Adjustments)

Time Allocation

Classroom, hours; laboratory, hours; shop, hours

Unit Objectives

To develop knowledge and skill in maintaining proper governor action and operation on a small four-stroke cycle engine
To orient students to making the adjustments required by the manufacturer

Tools and Materials

Student tool kit
Manufacturers' specifications
Tachometer

Instructional Procedure

Present the material by lecture, demonstration, discussion, and shop participation

Unit Outline

A. Purpose of governors

1. Keeps engine speed constant
2. Keeps engine speed in safe operating range
3. Protects operator and engine from dangerously high speed

B. Mechanical governor

1. Operates on centrifugal force

2. Uses counterweights

3. Will pull throttle to open position with engine stopped

4. Fast and smooth operating

5. Can be changed by varying tension on governor spring

6. Flywheel type uses round steel balls

C. Pnermatic or air vane governors

1. Governor works to hold throttle at governed position

2. Operator has full control at lower speeds

D. Servicing required on governors

1. Adjustment of speed adjusting nut

2. Cleaning of pivot pins, links, and arms

Laboratory Activity

During laboratory, the instructor should demonstrate adjusting various types of governors. He should also demonstrate procedures for cleaning and installing the governor assembly

Shop Activity

After an instructor demonstration, the students should practice making the governor adjustments using the tachometer
The students should work with all available types of governors within the specified shop time.

Texts and References

Long, Kenneth F. Small Engines Service Manual
Stephenson, George E. Small Gasoline Engines
Purvis, Jud. All About Small Gas Engines
Appropriate manufacturers' manuals

Teaching Aids

Wall Chart #6910102. Tecumseh Products Co.

Unit 8

Engine Cooling

Time Allocation

Classroom, hours; laboratory, hours; shop, hours

Unit Objective

To develop skill in performing routine preventative maintenance on the small gasoline engine cooling system

Tools and Materials

Student tool kit
Operating air-cooled engine

Instructional Procedure

Present material by lecture, discussion, and demonstration, and in shop participation by the student

Unit Outline

A. Purpose of engine cooling

    1. Dissipates heat caused by combustion

    2. Prevents engine part failure

    3. Maintains efficient engine operating termperature

B. Types of cooling systems

    1. Air cooled

    2. Water cooled

        a. Heat radiating fins

            (1) Located around cylinder and cylinder head to take heat from combustion chamber

            (2) Must be kept clean

        b. Shrouds for channeling air

C. Principles of operation

D. Temperature effects on wear and economy

E. Periodic servicing and maintenance

Laboratory Activity

The instructor should demonstrate the correct procedures for servicing a small gasoline cooling system

Shop Activity

When performing repairs on a small gasoline engine, each student should inspect all blower housings. Condition of fans should be checked. Each engine cylinder fin and cylinder should be thoroughly cleaned. Excess oil and fuel should be kept off cooling area.

Texts and References

Anderson, Edwin P. Audels Outboard Motor and Boating Guide
Atterberry, P. H. Power Mechanics
Stephenson, George E. Small Gasoline Engines
Appropriate manufacturers' manuals

Unit 9

Tune-up Techniques

Time Allocation

Classroom, hours; laboratory, hours; shop, hours

Unit Objectives

To develop skills in tune-up techniques
To encourage the student to become an expert small engine tune-up Specialist

Tools and Materials

Student tool kit
Timing devices
Coil tester
Tachometer
Spark plug tester and cleaner
Condenser tester
Compression gauge
Torque wrench

Instructural Procedure

Present the lesson by discussion and lecture and by student shop participation on operating engines.

Unit Outline

A. Troubleshooting ignition system

1. Procedures

2. Equipment and tools

B. Small engine tune-up

1. Spark plugs

a. Cleaning

b. Testing

c. Selecting heat range

d. Gap setting

e. Proper installation

f. Proper torque

2. Compression

a. How tested

b. Types of gauges

c. Wet compression

d. Dry compression

e. Cylinder leakage test

3. Air cleaners

a. How cleaned

b. What types

c. Purpose

4. Carburetor

a. Float adjustments

b. Low and high speed adjustments

c. Choke adjustments

d. Throttle adjustments

5. Governor

   a. Purpose

   b. How adjusted

6. Condenser

   a. Types of tests to make

   b. How installed

   c. Purpose

7. Coil

   a. Types of tests to make

   b. Purpose of magneto coil

   c. Air gap adjustment

8. Breaker points

   a. Howinstalled

   b. Proper adjustment

   c. Spring tension

   d. Point alignment

   e. Timing

9. Fuel filter

   a. Types

   b. Proper servicing

   c. Purpose of fuel filter

Laboratory Activity

Instructor should demonstrate proper tune-up procedures before the class in laboratory. He should explain each step in detail, and use all testing equipment, explaining their operation in full.
Orient students to tune-up manuals and testing equipment manuals
CIC: Compression, ignition, and carburetion essentials of tune-up on all engines should be understood by all students

Shop Activity

1. Engines in operating condition should be used for shop practice
2. A large variety of engines should be employed
3. The following tune-up procedure should be followed:

Inspect air cleaner
Clean gas tank, fuel lines, and filter
Check compression
Check spark plug
Check governor
Check magneto
Fill crankcase with clean oil
Fill gas tank with regular gasoline
Start engine
Adjust carburetor for peak performance
Have instructor check running engine
If completed properly, assign another tune-up

Texts and References

Clinton Engines Corp. 1965 Clinton Field Service Clinic Manual
Stephenson, George E. Small Gasoline Engines.
Tecumseh Products Co. Mechanics Handbook
Appropriate manufacturers' manuals

Teaching Aids

Spark Plug Cleaner. Briggs & Stratton
Checking Carburetor. Briggs & Stratton

Unit 10

Troubleshooting Techniques

Time Allocation

Classroon, hours; laboratory, hours; shop, hours

Unit Objective

To develop knowledge and skills necessary to locate engine troubles and malfunctions

Tools and Materials

Student tool kit
Testing equipment
Compression gauges
Spark plug tester and cleaner
Timing devices
Operating Engines

Instructional Procedure

Present material by lecture, discussion, demonstration, and student participation in the shop.

Unit Outline

A. Procedures for basic four-stroke cycle engine troubleshooting; determine as accurately as possible the parts that are faulty by isolating, testing and process of elimation

1. Checks when engine fails to start

a. No fuel in tank

b. Shut off valve closed

c. Obstructed fuel line

d. Tank cap vent plugged

e. Water in fuel

f. Engine flooded

g. Improper carburetor adjustment

h. Loose or defective magneto wiring

i. Faulty magneto

j. Fouled spark plug

k. Cracked spark plug porcelain

l. Poor compression

m. Improper throttle linkage adjustment

n. Not choking properly

o. Fuel valve sticks

p. Fuel pump diaphragm leaks

q. Improper air gap

r. Improper timing

2. Checks when engine misses under load

a. Fouled spark plug

b. Improper spark plug settings

2. Checks when engine misses under load (continued)

   c. Improper heat range of spark plug

   d. Oxidized magneto points

   e. Improper breaker spring tension

   f. Defective condenser

   g. Improper valve clearances

   h. Weak valve springs

   i. Breaker points out of adjustment

   j. Incorrect carburetor adjustment

3. Checks when engine lacks power

   a. Choke partly closed

   b. Air cleaner clogged

   c. Fuel filter clogged

   d. Magneto improperly timed

   e. Valves leaking

   f. Worn piston rings and cylinder walls

   g. Fuel level low

   h. Vapor lock

   i. Fuel pump diaphragm leaking

   j. Carburetor throttle does not open fully

   k. Improper governor action

   l. Ignition timing incorrect

   m. Spark plug gap incorrectly adjusted

4. Areas to be covered when the four-stroke cycle engine "knocks"

   a. Excessive carbon build-up

   b. Loose connecting rod

   c. Loose crankshaft bearings

4. Areas to be covered when the four-stroke cycle engine "knocks" (Continued)

   d. Loose flywheel

   e. Piston slap

   f. Loose piston pin

   g. Broken piston

   h. Foreign material on top of piston

   i. Incorrect fuel

5. Checks to be made when four-stroke cycle engine overheats

   a. Lean carburetor adjustment

   b. Overloaded engine

   c. Improper governor action

   d. Shrouds missing or loose

   e. Improper oil levels

   f. Incorrect types of oil

   g. Dirty or plugged cooling fins

6. Checks when four-stroke cycle engine surges or runs unevenly

   a. Governor linkages sticking

   b. Improper carburetor adjustment

7. Checks when engine vibrates

   a. Engine not mounted properly

   b. Misaligned or bent crankshaft

   c. Blade or drives and pulleys out of balance

B. Precautions necessary in troubleshooting

   1. Make sure engine is properly mounted

   2. Be careful of leaking fuel lines

Laboratory Activity

Instructor should demonstrate basic troubleshooting techniques on all types of engines. All testing equipment should be explained thoroughly and completely. Instructor should explain manufacturers' specifications and where to find them during troubleshooting. During laboratory activity, a student could troubleshoot an engine with the class observing his techniques.

Shop Activity

During shop time, four-stroke cycle engines should be mounted so they can be operated. A series of "troubles" or bugs should be inserted by the instructor on school-owned engines. Actual repair jobs should also be utilized if possible. A record should be kept on a progress chart to ensure each student of the same number of troubleshooting exercises. A record should be kept on the time it takes the student to find the trouble. With this information, the instructor can work on trouble areas during class time. Competition can be utilized to keep the student on his toes and to stimulate interest.

Texts and References

Automotive Electrical Association. AEA Air Cooled Engine Manual
Long, Kenneth F. Small Engines Service Manual
Purvis, Jud. All About Small Gas Engines
Stephenson, George E. Small Gasoline Engines

SECTION III

TWO-STROKE CYCLE ENGINES

	Instructural Unit	Instruction Time		
		Classroom Hours	Laboratory Hours	Shop Hours
1.	Engine Principles.....	3.0	1	5
2.	Lubrication.....	.5	0	1
3.	Ignition and Recoil Starter Systems...	1.5	0	3
4.	Carburetion and Fuel Systems.....	3.0	2	5
5.	Engine Speed Control (Governors and .. Linkage Adjustments).....	2.0	0	4
6.	Engine Cooling (Including Marine Engines)	1.0	2	3
7.	Tune-up Techniques.....	3.0	2	12
8.	Troubleshooting Techniques.....	3.0	2	15
9.	Major Engine Overhaul.....	12.0	5	25
10.	Routine Maintenance and Storage.....	1.0	1	8
	Totals.....	30.0	15	81

Section III presents the principles of two-stroke cycle engine operation. The emphasis in these units is on involving the student in laboratory and production jobs.

The instructor will present this unit by lecture, discussion, demonstration, and audio-visual aids.

The student will become involved in working on production jobs.

COURSE UNITS

Unit I

Engine Principles

Time Allocation

Classroom, hours; laboratory, hours; shop, hours

Unit Objective

To develop knowledge and skill in servicing the two-stroke cycle engine

To develop a sincere interest in doing a good job on every engine, troublesome as it may be

Tools and Materials

Student tool kit

Shop special tools

Ring compressor and expander

Seal tools

Instructional Procedure

Show, by lecture and demonstration, how the components of a two-stroke cycle engine function.

Unit Outline

A. Advantages of a two-stroke cycle engine

1. Light weight
2. Constant power
3. Smooth operation
4. Minimum maintenance
5. Easy for layman to operate
6. Can be operated in any position

B. Uses for two-stroke cycle engine

1. Lawn mowers
2. Chain saws
3. Motorcycles
4. Augers
5. Marine

C. Basic function of a two-stroke cycle engine

1. Intake and compression
2. Power and exhaust
3. Point of ignition
4. Power stroke every revolution
5. Fuel requirements
6. Lubrication of moving parts

D. Intake-compression stroke (upstroke)

1. Piston covers intake and exhaust ports
2. Piston compresses fuel mixture in the combustion chamber
3. Piston creates vaccum which opens reed valve
4. Vaccum draws vapor from carburetor into crankcase

E. Power-exhaust stroke (downstroke)

1. When piston is at top or near top of stroke
    a. Ignition occurs
    b. Ignited fuel drives piston down
    c. Downward thrust (linear) transferred
        1. Through connecting rod
        2. As rotary motion to crankshaft

2. Piston moves down

   a. Uncovers exhaust port

   b. Uncovers bypass intake port

   c. Compresses fuel mixture into combustion chamber

      (1) Closes reed valves

      (2) Forces new fuel mixture into combustion chamber

      (3) New fuel helps force exhaust gases out

F. Major moving parts

   1. Piston, pin and rings

   2. Connecting rod

   3. Crankshaft and bearings

   4. Reed valve

   5. Cause of movement

      a. Piston moved by expansion of burning gases

      b. Crankshaft rotates by action of connecting rod

      c. Reed valves act because of pressure and partial vacuum

G. Carburetor

   1. Draws in liquid fuel and air

   2. Vaporizes the fuel

   3. Mixes fuel vapor and air

   4. Discharges mixture through reed valve

      a. Into crankcase

      b. During intake-compression stroke

   5. Venturi tube

      a. Physical qualities

      b. Function

      c. Why it works

6. Reeds and rotary types

   a. Comparison to valves in four-stroke cycle engine

   b. Location

   c. Opens by vacuum during upstroke

   d. Closes because of pressure in crankcase during downstroke

7. Choke

   a. Description

   b. Function

      (1) Restricts flow of air to carburetor

      (2) Results of varying degrees of choking

8. Primer

   a. Description

   b. Advantages

H. Magneto

1. Self-contained unit

2. Magneto components

   a. Armature plate

   b. Ignition coil

   c. Condenser

   d. Breaker points

   e. Permanent magnet

3. Magnet's function: Provides high voltage current in coil by induction

   a. Causes spark to jump gap between spark plug electrodes

   b. Causes current to flow through primary winding

4. Crankcase

5. Cam

   a. Location

   b. Operation

6. Condenser

   a. Location

   b. Function

7. High tension lead wire

   a. Location

   b. Function

8. Spark plug

   a. Function

   b. Location

   c. Physical qualities

   d. Heat ranges

9.. Coil

   a. Components

      (1) Soft laminated iron core

      (2) Primary winding consisting of few turns of heavy copper wire

      (3) Secondary winding consisting of many turns of fine copper wire

      (4) Insulation jacket around the winding

   b. Function

Laboratory Activity

It is suggested that several makes of worn engines by used for shop activity to give each student a chance to check different makes of engines for worn parts as they actually occur in the field.

Laboratory Activity (continued)

1. Disassemble short block assembly.
2. Examine and measure crankshafts and journals for taper and out of round.
3. Examine bearings for wear, pits, and scratches.
4. Measure bearing clearances using plastic ribbon.
5. Measure bearing clearances using shim stock.
6. Check connecting rod alignment.
7. Check out of round of connecting rods.
8. Examine piston pins for wear, locks, and clearances.
9. Measure piston for size and wear.
10. Check piston for cracks, worn grooves, and worn lands.
11. Check piston clearances with a feeler ribbon and spring scale.
12. Check for worn rings; measure ring gap and groove clearances of rings.

Texts and References

Clinton Engines Corp. 1965 Clinton Field Service Clinic Manual

Lawn-Boy Corp. Lawn-Boy Mechanics Handbook

Long, Kenneth F. Small Engines Service Manual

McCulloch Corp. The Two Cycle Engine

Stephenson, George E. Small Gasoline Engines

Tecumseh Products Co. Mechanics Handbook

Unit 2

Lubrication

Time Allocation

Classroom, hours; laboratory, hours; shop, hours

Unit Objectives

To equip the student with knowledge and skills necessary to lubricate the two-stroke cycle engine.

Tools and Materials

Two-stroke cycle engine

Gasoline and oil

Student tool kit

Instructional Procedure

Present material by lecture, discussion, demonstration and student participation in the shop.

Unit Outline

A. Oil in fuel lubrication

    1. Proper amounts perengine

    2. Nondetergent oil

    3. Detergent oil

B. Types of lubricating oils used

    1. Service ML

    2. Service MM

    3. Service MS

    4. Service DG

    5. Service DM

C. Four tasks of lubricating oil in an engine

1. Cooling
2. Sealing
3. Lubricating
4. Cleaning

D. SAE oil number

1. Weights
2. Pour depressants
3. Oil molecules

Laboratory Activity

The instructor shouldmmix fuels properly and stress safety in the handling and use of gasoline in the shop. A demonstration of burned fuel and oil can be used to show the oils left after burning.

Shop Activity

Students should be given the chance to mix fuel and oil in correct amounts for a two-stroke cycle engine.

Incorrect mixtures of fuel and oil can be used in the engine to illustrate malfunctions cause by careless fuel preparation.

Students should be given the chance to see or disassemble an engine which has had no lubrication at all. All parts should be studied by the entire group.

Texts and References

Purvis, Jud. All About Small Gas Engines.

Clinton Engines Corp. 1965 Clinton Field Service Clinic Manual

Long, Kenneth F. Small Engines Service Manual

McCulloch Corp. The Two Cycle Engine

Stephenson, George E. Small Gasoline Engines

Tecumseh Products Co. Mechanics Handbook

Unit III

Ignition and Recoil Starter Systems

Time Allocation

Classroom, hours; shop, hours

Unit Objectives

To develop the knowledge and skill required for the different types of ignition and recoil starter systems for two-stroke cycle engines.

Tools and Materials

Student tool kit

Special Manufacturers' tools and pullers

Service manuals for proper engine models

Instructional Procedure

Teach the types of ignition systems and starter systems used on the two-stroke cycle engine by lecture, discussion, and demonstration.

Unit Outline

A. Magneto systems

1. Permanent magnetos

a. Materials used in the construction of magnetos

b. Alnico magnets

2. Laminated soft iron cores and their advantages

3. Coils

a. Primary windings; amount and size of wire

b. Secondary windings; amount oand size of wire

4. Breaker points

a. Materials used in breaker points

b. Adjustment of breaker points

c. Cams used on crankshaft

5. Condenser

    a. Purpose of the condenser

    b. How condenser is mounted

6. Spark plug

    a. Purpose of the spark plug

    b. Air gap

    c. Adjusting air gap

    d. Reach

    e. Size

    f. Heat range

B. Magneto system operation

1. Rules of magnetism affecting operation of a magneto system

    a. Lines of force

    b. Variation of magnetic lines of force

    c. Existing lines of force

2. Primary circuit collapse

3. Secondary current voltage

4. Condenser discharging

C. Recoil starter systems

1. Principles of recoil starters

2. Parts of a recoil starter

    a. Shroud

    b. Spring

    c. Pulley

    d. Rope

    e. Housing

3. Methods of securing rope

   a. Bead stop

   b. Rope clamp

4. Methods of installing new rope

   a. Burning of ends for installation

   b. Inserting rope with stiff wire

5. Springs

   a. Types

   b. Replacement

   c. Winding

   d. Locking

   e. Amount of winding

Shop Activity

Have the students remove, inspect, and overhaul various designs of recoil starter systems and ignition systems.

1. Remove shroud or housing.

   Remove starter spring and pulley.

   Rewind spring.

   Install rope.

   Fasten spring to pulley.

   Install shroud assembly

2. Remove flywheel, using puller available for each engine.

   Inspect points

   Test condenser

   Test coil

   Check for loose or broken wires

   Check point gap and spring tension

   Install cover and flywheel

   Test for spark of proper value

Texts and References

Briggs & Stratton. Repair Instructions II.

Clinton Engines Corp. 1965 Clinton Field Service Clinic Manual

Lawn-Boy Corp. Lawn-Boy Mechanics Handbook.

Long, Kenneth F. Small Engines Service Manual

McCulloch Corp. The Two Cycle Engine

Long, Kenneth F. Outboard Motor Service Manual

Stephenson, George E. Small Gasoline Engines

Tecumseh Products Co. Mechanics Handbook

Appropriate manufacturers' manuals.

Unit 4

Carburetion and Fuel Systems

Time Allocation

Classroom, hours; laboratory, hours; shop, hours

Unit Objective

To develop knowledge and skills in carburetion and fuel systems found on two-stroke cycle engines.

Tools and Materials

Student tool kit

Manufacturers' recommended carburetor tools

Several makes and models of two-stroke cycle engine carburetors and fuel pumps

Instructional Procedure

Present the types of carburetors used on two-stroke cycle engines, along with proper settings and adjustments, by lecture, discussion, and demonstration.

Unit Outline

A. Principles of operation

B. Requirements of carburetion on two-stroke cycle engines

C. Carburetor circuits--function

1. Float circuit

2. High speed circuits

3. Low speed circuits

4. Choke circuit

D. Components of carburetors

1. Float

a. Needle and seat

b. Types of floats used

2. High speed circuit

a. Main jets and main needle

b. Discharge nozzles

3. Low speed circuit

a. Idle tubes

b. Air bleeds

c. Mixture screws

d. Discharge holes

e. Low speed needles

4. Choke circuit

a. Types of butterfly chokes

b. Types of primers

E. Carburetor service needs

1. Special tools and gauges

2. Troubleshooting charts

3. Cleaning chemicals

4. Carburetor kits

a. Gasket kits

b. Complete overhaul kits

c. Service kits

F. Reed valves and rotary valves

1. Types of reed valves used

2. Purpose of reed valves

a. Importance of proper maintenance and servicing

b. Handling

3. Types of rotary valves

4. Purpose of rotary valves

a. Importance of proper maintenance and servicing

b. Handling

G. Fuel pumps

1. Types

2. Adjustments

H. Gravity flow systems

I. Vent cap construction

J. Fuel lines

1. Types

2. Repairing

K. Filters

1. Types

2. Servicing

L. Shut-off valves

1. Types

2. Maintenance

M. Diaphragm type

1. Operation

2. Gravity fed

Laboratory Activity

1. Identify makes of carburetors

2. Determine applications

3. Disassemble one carburetor of each type

4. Identify all circuits within carburetor

5. Make all necessary adjustments internally

6. Reassemble carburetor

7. Make external adjustments

Shop Activity

Students should completely disassemble several makes and models of carburetors found on two-stroke cycle engines

1. Remove, clean, and inspect several makes of carburetors

2. Make all internal adjustments

3. Locate all internal circuits

4. Reassemble and make external adjustments

5. Follow all manufacturers' specifications regarding each make of carburetor.

Texts and References

Clinton Engines Corp. 1965 Clinton Field Service Clinic Manual
Lawn-Boy Corp. Lawn-Boy Mechanics Handbook
Long, Kenneth F. Small Engines Service Manual
Long, Kenneth F. Outboard Motor Service Manual
Purvis, Jud. All About Small Gas Engines
Tecumseh Products Co. Mechanics Handbook
Appropriate manufacturers' manuals

Unit 5

Engine Speed Control (Governors and Linkage Adjustments)

Time Allocation

Classroom hours

Unit Objective

To develop knowledge of engine speed controls and governors found on two-stroke cycle gasoline engines

Tools and Materials

Governor adjusting tools

Several types of governors

Student tool kit

Instructional Procedure

Explain the types of two-stroke cycle governors and linkage adjustments
Demonstrate necessary adjustments using manufacturers' special tools

Unit Outline

A. Purpose of governors

B. Types of governors

1. Mechanical flyball governors

a. How driven, principles of operation

b. Adjustments to be made

2. Vacuum governors

a. How driven, principles of operation

b. Adjustments to be made

c. Troubleshooting vacuum governors

3. Air vane-type governors

a. How driven, principles of operation

b. Importance of spring tension

c. Linkage replacement and adjustments

3. Air vane-type governors (continued)

   d. Condition of blower housing

   e. Maintenance of air vane governors

4. Variable speed governors

   a. Principles of operation

   b. Where located

   c. Adjustments to make

5. Centrifugal governors

   a. Principles of operation

   b. Where located

   c. Maintenance and adjusting

Texts and References

Briggs & Stratton, Repair Instructions II

Clinton Engines Corp. 1965 Clinton Field Service Clinic Manual

Lawn-Boy Corp. Lawn-Boy Mechanics Handbook

Long, Kenneth F. Small Engines Service Manual

Stephenson, George E. Small Gasoline Engines

Purvis, Jud. All About Small Gas Engines

Tecumseh Products Co. Mechanics Handbook

Appropriate manufacturers' manuals

Unit 6

Engine Cooling (Including Marine Engines)

Time Allocation

Classroom, hours; laboratory, hours; shop, hours

Unit Objective

To supply the student with the knowledge and skills to service the small engine cooling system.

Tools and Materials

Student tool kit

Live air-cooled engine

Water-cooled engine- outboard

Instructional Procedure

Present material by lecture, discussion, demonstration, and student participation in the shop

Unit Outline

A. Cylinder fins

1. Circular ribs around the cylinder head
2. Purpose of fins
3. Engines run in excess of 200°

B. Fans and blowers

1. Series of vanes
2. Driven by the flywheel

C. Shrouds

1. Protection to operator
2. Direct flow of air

D. Water cooling, two-stroke cycle engine; water pump

1. Eccentric rotor
2. Centrifugal
3. Can actuated plunger
4. Vane type

E. Thermostatic controls

F. Servicing the water pump

1. Remove water pump body and lift off the pump
2. Remove water pump impeller drive key

F. Servicing the water pump (continued)

3. Inspect all water pump parts for wear or damage

4. Install new water pump gasket

5. Clean up all passages completely

6. Replace intake screen

Shop Activity

In order to become acquainted with all types of cooling systems, students should be given a chance to remove cooling systems for inspection and repair.

1. Service air-cooled systems

   Inspect all blower housing

   Remove shrouds, and clean air passages

   Check all fins on flywheels

2. Service water-cooled systems

   Remove lower unit

   Remove impeller, and examine

Texts and References

Anderson, Edwin P. Audels Outboard Motor and Boating Guide

Atterberry, P. H. Power Mechanics

Purvis, Jud. All About Small Gas Engines

Stephenson, George E. Small Gasoline Engines

Appropriate manufacturers' manuals

Unit 7

Tune-up Techniques

Time Allocation

Classroom, hours; shop, hours

Unit Objectives

To develop skill in performing engine tune-ups on two-stroke cycle engines
To orient students to preventative maintenance
To encourage the student to become an expert tune-up man and to do quality work on everyjob.

Tools and Materials

Timing devices

Compression gauges

Spark plug tester and cleaner

Student tool kit

Condenser tester

Tachometer

Coil tester

Instructional Procedure

Orient students to the tune-up procedures required to properly maintain the small two-stroke cycle engines. Use the lecture and demonstration methods and shop assignments

Unit Outline

A. Minor engine tune-up--two-stroke cycle

1. Clean, regap, or replace spark plug
2. Test compression
3. Clean air cleaner
4. Adjust carburetor
5. Clean fuel tank, line, and filter
6. Adjust governor speed

B. Spark plug service

1. Test plug condition
2. Check heat range
3. Electrode wear
4. Diameter
5. Reach
6. Fouled spark plug
7. Wire installation for stripped plug threads

C. Compression

1. Use of compression gauge
2. Compression specifications
3. Wet compression test
4. Dry compression test
5. Compression piston ring's function

D. Cleaning air cleaner

1. Proper procedures
2. Types
3. Function
4. Installation procedures

E. Adjusting carburetor

1. Low speed
2. High speed
3. Float adjustment
4. Choke adjustment
5. Installation procedures
6. Cleaning procedures

F. Fuel tank line and filter

1. Fuel tank location
2. Types of fuel lines
3. Filter location
4. Proper filter replacement
5. Proper cleaning of filters

G. Adjusting governor speed

1. Inspect for obvious visual malfunctions
2. Broken or worn parts

3. Sticking weights

4. Improper installation of linkage

H. Major tune-up

1. Check spark plug gap or replace spark plug

2. Test compression

3. Clean oil filter

4. Remove carburetor and overhaul

5. Clean fuel tank line and filter

6. Adjust governor speed

7. Inspect reed valve

8. Test condenser

9. Test coil

10. Install and adjust new breaker points

11. Clean carbon from muffler and exhaust parts

Shop Activity

1. Instructor should demonstrate the use of all testing equipment for tune-up
2. Each trainee should be given a chance to completely tune-up all types of engines available
3. The students should refer to and look up all their own specifications on the particular engine they are tuning
4. As the student's progress warrants, malfunctions should be installed in the units for tune-up

Texts and References

Clinton Engines Corp. 1965 Clinton Field Service Clinic Manual

Long, Kenneth F. Small Engines Service Manual

Stephenson, George E. Small Gasoline Engines

Tecumseh Products Co. Mechanics Handbook

Appropriate manufacturers' manuals

Unit 8

Troubleshooting Techniques

Time Allocation

Classroom, hours; laboratory, hours; shop, hours

Unit Objective

To develop the student's skills inthe field of troubleshooting

Tools and Materials

Troubleshooting charts and bulletins

Manufacturers' manuals

Magneto coil and condenser tester

Compression tester

Operating engines

Student tool kit

Tachometer

Instructional Procedure

Discuss all types of troubles that can be encountered in working with two-stroke cycle engines. Demonstrate the ways and means for students to find the malfunctions quickly and accurately. During the shop time, let the student try to find troubles that have been rigged into operating engines or troubleshoot engines brought into the shop by customers or students.

Unit Outline

A. Fuel system malfunctions causing engine hard start

1. No fuel in tank
2. Fuel shut-off valve position
3. Screen condition
4. Fuel filter condition
5. Obstructed fuel line
6. Fuel tank vents

A. Fuel system malfunctions causing engine hard start (continued)

7. Engine flooded
8. Water in fuel
9. Improper choking
10. Throttle plate opening
11. Needle valve
12. Governor operation
13. Reed valves
14. Carburetion jet plugged
15. Fuel pump diaphragm
16. Air leaks
17. Fuel filters
18. Air filters
19. Vapor lock
20. Improper fuel mixture
21. Improper fuel

B. Ignition system causing malfunction; breaker point assembly

1. Pitted
2. Wet
3. Grounded
4. Excessive resistance
5. Improper adjustment
6. Pubbing block condition
7. Binding
8. Spring tension

C. Magneto system

1. Types

a. Flywheel

b. Rotating magnet

2. Important maintenance checks

a. Air gap adjustment

b. Leads and terminals

c. Condenser action

d. Ignition switch

e. Magnet condition

f. Torque on flywheel (loose flywheel)

g. Condition of key or key-way

h. Continuity test

D. Causes of poor compression (parts to check)

1. Piston rings

2. Seals and gaskets

3. Piston

4. Cylinder wall condition

5. Reed valve

6. Cylinder head

E. Engine overheats

1. Shroud condition

2. Fins clogged

3. Air flow reduced

4. Improper timing

5. Carbon building up

B. Engine overheats (continued)

6. Excessive load

7. Clearances within engine

. Fuel ratio

. Oil mixture

E. Loss of power in two-stroke cycle engine (cause)

1. Dirty muffler

2. Air cleaner requires service

3. Parts clogged

4. Maladjusted carburetor

5. Overheating

6. Carburetor and governor linkage adjustments

7. Dirty fuel system

. Incorrect timing

9. Poor compression

10. Condenser faulty

11. Fouled spark plug

12. Hot spots

13. Pre-ignition

14. Detonation

15. Reed valve not closing

16. Improper fuel

17. Insufficient throttle valve opening

F. Two-stroke cycle stalls or surges (cause)

1. Governor linkage sticking

2. Throttle linkage sticking

3. Reed valve action faulty

G. Two-stroke cycle stalls or surges (continued)

4. Maladjusted carburetor

5. Fuel filter clogged

6. Improper breaker point adjustment

7. Faulty spark plug

8. Loose primary and secondary leads

9. Defective shut-off switch

10. Engine overheat

11. Contaminated fuel

H. Two-stroke cycle engine vibrates excessively

1. Unbalanced or loose blade

2. Improper mountings

3. Bent crankshaft

4. Damaged cooling fins

5. Worn main bearings

6. Loose or unbalanced flywheel

7. Unbalanced piston and rod assembly

I. Engine knocks (causes)

1. Carbon knock

2. Loose connecting rod

3. Improperly torqued flywheel

4. Improperly torqued blade

5. Broken piston rings

6. Worn piston pin

7. Damaged housing and shrouds

8. Improper timing

9. Improper fuel

Laboratory Activity

Instructor should demonstrate a systematic method of troubleshooting and go through a complete test on each faulty engine.

Shop Activity

Two-stroke cycle engines should be mounted so they can be operated, and a series of "troubles" should be inserted by the instructor. A record or progress chart should be kept to ensure that each student is exposed to all types of problems during the time allotted to troubleshooting. During shop troubleshooting, the student should develop the proper skills to increase the speed with which he finds the problems. The time element should also be recorded on the progress chart. To develop interest, competition can be a stimulating factor in getting the student to follow an accurate and systematic troubleshooting pattern.

Texts and References

Automotive Electrical Association. A.E.A. Air Cooled Engine Manual

McCulloch Corp. Small Power Package

Stephenson, George E. Small Gasoline Engines

Tecumseh Products Co. Mechanics Handbook

Appropriate manufacturers' manuals.

Unit 9

Major Engine Overhaul

Time Allocation

Classroom, hours; shop, hours

Unit Objective

To develop knowledge and skills in the overhaul of two-stroke cycle engines

Tools and Materials

Two-stroke cycle engines of various makes and models

Special factory tools used in overhaul

Student tool kit

Cleaning fluids

Engine holding fixtures

Tools and Materials (continued)

Torque wrench, inch-pound

Parts trays

Micrometer

Telescoping gauge

Instructional Procedure

By lecture and shop assignment, teach disassemble procedures, inspection of parts for wear, measuring of parts for serviceability and wear limits, adjustments, and assembly procedures of the two-stroke cycle engine.

Unit Outline

A. Preparation

1. Remove engine from unit
2. Use special disassembly tools
3. Clean exterior of engine before disassembly

B. Disassembly

1. Disconnect gas line from carburetor
2. Remove plug wire
3. Remove flywheel nut and washer
4. Lift off starter pulley, plate, screen, pin, and spring from flywheel
5. Remove flywheel; use proper puller
6. Lift off governor yolk arms and collar if used on this engine
7. Remove governor spring if used
8. Remove complete magneto plate
9. Remove carburetor air filter and reed plate assembly
10. Note markings on connecting rod caps; remove connecting rod cap screws
11. Remove cylinder head bolts and gasket

B. Disassembly (continued)

12. Remove piston, rod and ring assembly from cylinder

13. Remove the crankshaft

C. Cleaning

1. Check parts for restrictions and clean if necessary

2. Clean all internal parts for inspection

D. Inspection for necessary adjustments, repairs, or replacements

1. Check cylinder cooling fins for breaks

2. Check cylinder bore for score marks

3. Measure cylinder for taper wear and out of round

4. Check piston clearance using a feeler gauge

5. Inspect and measure crankshaft bearing journals; check for overheating

6. Inspection of bearings

a. Plain bearings

b. Ball bearings

c. Bearing end play correction on plain bearings

d. Needle crankpin bearings

e. Removal and installation of ball bearings

7. Oil seals

a. Types used

b. Replacement of oil seals

8. Piston rings

a. Oil rings

b. Compression rings

c. Scraper rings

d. Proper use of ring compressor

e. Ring and gap clearance check

9. Connecting rod

   a. Inspection of bearings

   b. Check for cracks

   c. Check for thread and screw condition

   d. Checking connecting rod clearance

      (1) Shim or feeler stock method

      (2) Plastic string method

      (3) Micrometer

10. Cylinder head

   a. Clean all carbon from parts

   b. Check for warpage using a surface plate and feeler gauge

11. Magnetos

   a. Check for loose mounting screws

   b. Check air gap

   c. Check condition of points

   d. Check fiber block for wear

   e. Check for wear between crankshaft and magneto plate bearing

   f. Test coil and condenser

   g. Adjust ignition points to proper specified gap

   h. Check primary and secondary wire for insulation breaks

E. Reassembly

F. Service testing

   1. Make external adjustments on engine in operation

   2. Reinstall in unit

   3. Retest under load

Shop Activity

Each student should completely disassemble, inspect parts, measure for clearances, and reassemble several makes and models of two-stroke cycle engines. These engines should be operating engines of the vertical and horizontal shaft types.

1. Remove engine from machine
2. Clean external engine parts
3. Mount engine in test stand
4. Select proper manufacturers' manuals for make and model
5. Completely disassemble engine following manual procedures
6. Clean all internal parts
7. Thoroughly inspect all parts for wear, cracks, and markings
8. Measure parts, and refer to service manual for wear limits
9. Replace worn parts
10. Reassemble engine after all inspections are made and all worn parts replaced
11. Follow the service manual's reassembly procedures
12. Use torque wrenches on each engine where torque specifications are given
13. Run engine and make necessary external adjustments
14. Install on machine
15. Retest under load

Texts and References

Lawn-Boy Corp. Lawn-Boy Mechanics Handbook

Long, Kenneth F. Small Engines Service Manual

Long, Kenneth F. Outboard Motor Service Manual

Purvis, Jud. All About Small Gas Engines

Tecumseh Products Co. Mechanics Handbook

Appropriate manufacturers' manuals

Unit 10

Routine Maintenance and Storage

Time Allocation

Classroom, hours; shop, hours

Unit Objective

To develop knowledge and skills in the routine maintenance and storage of the two-stroke cycle engine

Tools and Materials

S.A.E. 30 engine oil

Wrapping materials--canvas, blanket, paper, or polyethylene

Student tool kit

Cleaning fluids

Instructional Procedure

Inform the student of the normal maintenance procedures required for an engine and how to properly prepare an engine for storage. Use lecture method and shop assignment.

Unit Outline

A. Maintenance

1. Servicing air cleaner
    a. Wet or gauze type
    b. Dry or paper type
2. Blade care
    a. Sharpen cutting edges
    b. Check for bent blades
    c. Check for unbalanced condition
3. Carbon removal
    a. Remove muffler
    b. Scrape from muffler and parts

4. Spark plug

   a. Remove spark plug

   b. Clean and gap plug

   c. Check condition of electrodes

5. Cylinder fins

   a. Remove baffle plates, if used

   b. Blow out cylinder fins with air

6. Clean external parts and grease

7. Remove excess oil or grease

8. Check for operation and freeness of governor

B. Storage of engines

1. Drain all fuel from tank, fuel line, and carburetor

2. Remove spark plug

3. Pour approximately one tablespoon of oil through spark plug hole

4. Turn flywheel slowly to distribute the oil

5. Replace spark plug

6. Wrap engine in canvas, old blanket material, heavy paper, or polyethylene

7. Store in a dry place

Shop Activity

Select several engines of various makes and models of the two-stroke cycle design and have students perform proper maintenance on each engine.

Perform routine maintenance on air cleaner, blade, spark plug, cylinder fins, external parts (using approved cleaning fluid), and governor (checking for operation and freeness).

Prepare several engines for storage, as follows:

Clean grease from outside

BEST COPY AVAILABLE

Drain fuel tank, lines, and carburetor

Insert oil in spark plug hole

Turn flywheel slowly

Replace spark plug

Wrap in polyethylene or similar material for storage.

Texts and References:

Lawn-Boy Corp. Lawn-Boy Mechanics Handbook

Long, Kenneth F. Outboard Motor Service Manual

Stephenson, George E. Small Gasoline Engines

Teaching Aids

Briggs & Stratton. Slide Set #5, Stop, Start and Store

SECTION IV

BUSINESS PROCEDURES

Instructional Unit	Instruction Time	
	Classroom hours	Laboratory hours
1. Business Procedures.....	3	2
2. Customer Relations.....	3	1
Totals.....		

The emphasis in this course has been on the training of small engine repairmen. This section presents some of the management techniques involved in the successful operation of a business and the responsibility of the serviceman to the customer and the shop owner.

COURSE UNITS

Unit 1
Business Procedures

Time Allocation

Classroom, hours; laboratory, hours

Unit Objectives

To present an overview of a small engine repair shop business operation
To present the knowledge and method necessary to determine the labor rate
To develop an appreciation for the responsibility of the manager

Tools and Materials

Samples of records common to the small engine repair business

Instructional Procedures

Present this unit by lecture, reading assignments, and discussion

Unit Outline

A. Facilities

1. Sales entrance

a. Enables customer to get prompt service

b. Clean, comfortable waiting area

A. Facilities (continued)

2. Service entrance

a. Oversize door

b. Easy access from parking area

3. Display area

a. Attractive setting

b. Sufficient room for display

c. Good lighting

d. Proper arrangement for impulse buying

4. Service area

a. Estimating area

(1) Job ticket file

(2) Appropriate counter displays

b. Stock room area

(1) Boxes for small parts

(2) Stock bins

(3) Racks for large parts

(4) Inventory

c. Cleanup area

(1) Steam cleaner

(2) Miscellaneous cleaning equipment and supplies

d. Shop area

(1) Work benches

(2) Tool board

(3) Service manuals

(4) Portable work benches

(5) Applicable shop equipment

e. Reel grinding and blade sharpening

(1) Location

(2) Safety precautions

B. Advertising

1. Personal contact with dealers without service center

2. Newspaper advertisements

a. Daily in summer

b. Occasionally in winter

3. Yellow pages of telephone directory

4. Radio announcements

5. Direct Mailing

6. Direct contact with customers

C. Off-season business

1. Gives customer advantage of off-season servicing

a. Unit ready when needed

b. Free storage

2. Creates work for employee

3. Insures profit for the owner

D. Records

1. Reasons for recordkeeping

a. To determine profit or loss

b. To substantiate tax reports

c. To present information when applying for credit

d. Inventory control

e. To determine overhead

2. Types of records

   a. Cash receipts and cash payments journal

   b. Credit sales record

   c. Profit or loss statement

   d. Record of purchases

   e. Required government reports

   f. Payroll records

   g. Sales tickets

   h. Repair order forms

E. Money management

   1. Capital cash; used for

      a. Building

      b. Fixtures

      c. Machinery

      d. Tools

      e. Inventory

   2. Income cash; used for

      a. Parts

      b. Labor costs

      c. Overhead expenses

   3. Determining net worth: value of buildings, fixtures, equipment, materials, etc., less amount due

   4. Determining working capital

      a. Cash on hand

      b. Value of inventory

5. Obtaining maximum profit

   a. Proper level of parts inventory

   b. Proper labor rate

   c. Realistic overhead cost

F. Labor rates

   1. Must fit the community

   2. Must provide adequate income

   3. Must be acceptable to the customer

G. Computing labor rates

   1. Determine income goal for a period

   2. Determine current and long-range expenses for the same period

   3. Consider lost time

   4. Divide sum of one and two by productive hours

   5. Readjust as required

H. Income outside of labor

   1. Sale of parts

   2. Sale of equipment

I. Expenses of the business

   1. Owner's rate of pay

   2. Pay to employees

   3. Rent

   4. Light, heat, and power

   5. Telephone

   6. Delivery equipment

   7. Depreciation

8. Insurance

9. Donations, Dues, subscriptions

10. Supplies

11. Office costs

12. Advertising

13. Repair costs

14. Required licenses

15. Equipment and tools

J. Types of business organization for small engine repair shop

1. Proprietorship, advantages of

a. One owner

b. Small number of employees

c. Limited amount of capital

d. Easy to organize

e. Easy to terminate

f. Owner the boss

g. Profits and losses to owner

h. Limited number of government regulations

i. Taxes

2. Proprietorship, disadvantages of

a. Difficult to raise capital

b. Owner on his own

c. Risk to owner

d. Limited life of business

3. Partnership, advantages of

a. Combined knowledge

b. Additional capital

c. Sharing of responsibility

3. Partnership, advantages of (continued)

   d. Easier credit

   e. Limited government control

   f. Ease of organization

4. Partnership, disadvantages of

   a. Liability for decision of partner

   b. Personality problems

   c. Limited life of business

   d. Limits on expansion

Laboratory Activity

Undertake a field trip to sole owner and a partnership small engine shop

Texts and References

Automotive Electrical Association. The Economic Facts of Life for the Small Engine Service Dealer.
Hailes & Hubbard. Small Business Management.

Unit 2

Customer Relations

Time Allocation

Classroom, hours; laboratory, hours

Unit Objectives

To develop an understanding of the importance of customer relations
To develop an understanding of the ingredients of good customer relations
To develop an understanding of the customer

Instructional Procedure

Present this unit by lecture, discussion, and demonstration.
Present good and bad examples of customer relations. Involve the students by having them relate personal experiences in customer relations. Involve the students through the medium of role playing in good and bad examples of customer relations.

Unit Outline

A. The customer and the owner: customer is the boss

1. Has choice of service centers
2. Has money to pay for service
3. Has influence with his friends
4. Can help to create a good reputation

B. The customer

1. Reasons for buying
   a. Definite need for service product
   b. Possible use for the product or service
   c. To add to wealth
   d. To satisfy pride of ownership
   e. To provide safety
   f. To provide comfort
   g. To provide profit
   h. To provide pleasure
2. Reasons for buying at a specific shop
   a. Good reputation of owner
   b. Good reputation of serviceman
   c. Cleanliness of shop
   d. Personalities of employees
   e. Morals of employees
   f. Locality
   g. Advertised products handled
   h. Availability of parts
   i. Fast service

C. The serviceman and the customer

1. What the customer expects

a. Quality work and material

b. Honest answers to questions

c. Courteous treatment

d. Good service

e. Explanation of service needed

(1) Fair repair costs

(2) Fair replacement costs

f. Display of interest by the serviceman

g. Knowledge of the service by the serviceman

h. Presentable appearance

(1) Clean uniform

(2) Clean shave

(3) Clean breath

(4) Clean body

(5) Acceptable haircut

(6) Good habits

2. Handling customer complaints

a. Getting customer away from other customers

b. Listening carefully

c. Keeping your temper

d. Customer safety

e. Restating the problem

f. Settling the complaint immediately according to established policy

g. Giving customer the benefit of any doubt

D. Results of good customer relations

1. Repeat service sales

2. Sales to friends of customers

3. Increased income for business

4. Possible increase in serviceman's salary

5. Assurance of steady employment

Laboratory Activity

Demonstration by instructor and/or resource person showing proper and improper methods of dealing with customers in typical situations.

Texts and References

Collazzo, Charles G. Building Good Customer Relations
Entenberg, Robert D. Are You Selling Enough Service.
Ernest & DaVall. Salesmanship Fundamentals
Vreeland, Richard C. Customers, A Neglected Sales Force

Teaching Aids

A. P. Parts Corp. Say It With Service.

BIBLIOGRAPHY

Anderson, Edwin P.
Audel's Outboard Motor and Boating Guide. New York: Theo. Audel and Co., 49 West 23rd St., 1963

Atterberry, P. H.
Power Mechanics. Chicago: Goodheart-Wilcox Co., Inc. 1322 South Wabash, 1961

Automotive Electrical Association.
A.E.A. Air Cooled Engine Manual. Cleveland, Ohio and Burlington, Wis.: The Mischka Co., Inc., 1966

-----The Economic Facts of Life for the Small Engine Service Dealer; Vol. I, Financial. Detroit, Mich.,: A.E.A. Engine Service Institute, 16223 Meyers Road, 1968

-----Principles of Operation, Service, Maintenance Air Cooled Engines. Detroit, Mich.: A.E.A. Engine Service Institute, 16223 Meyers Road, 1968

-----Small Engine Powered Equipment. Detroit, Mich.: A.E.A. Sales and Service Center, 16223 Meyers Road,

Bowman Products Co.
General Repair Tools for Automotive Mechanics. Cleveland, Ohio: 850 East 72nd St.

---- Things You Should Know About Fasteners. Cleveland, Ohio: 850 East 72nd St., 1964

Briggs and Stratton.
General Theories of Operation. Milwaukee, Wis.: Briggs & Stratton Corp.

-----Parts Manual, Milwaukee, Wis,: Briggs & Stratton Corp.

-----Repair Instructions II. Milwaukee, Wis: Briggs & Stratton Corp.

Clinton Engines Corp.
1965 Clinton Field Service Clinic Manual. Form No. S1213 DESCO. Maquoketa, Iowa: The Clinton Engines Corp., 1965

-----Parts Manual. Maquoketa, Iowa: The Clinton Engines Corp.

Collazzo, Charles G.
Building Good Customer Relations. Small Marketers Aids No. 120. Nearest SBA Office: Small Business Administration, April 1966

Entenberg, Robert D.
Are You Selling Enough Service. Small Marketers Aids No. 81. Nearest SBA Office: Small Business Administration, August 1962

Ernest, John W. and George M. DaVall.
Salesmanship Fundamentals. Chicago: McGraw-Hill Book Co., Inc., Gregg Publishing Division, 1959

General Motors, Ind.
ABC's of Hand Tools. Detroit, Mich.: General Motors, Inc.

General Repair Tools
Manual. Albany, N. Y.: Delmar Publishing Co., 1965

Hailes, William D., Jr., and Raymond T. Hubbard.
Small Business Management. Albany, N.Y., Delmar Publishing Co., 1965

Lawn-Boy Corp.
Lawn-Boy Mechanics Handbook. Galesburg, Ill.: The Lawn-Boy Corp.
Long, Kenneth F., Ed.
Small Engines Service Manual, 7th ed. Kansas City, Mo.: Technical Publications, Inc., Implement and Tractor Publications, Inc., 1014 Wyandotte St., 1964
-----Outboard Motor Service Manual, 3rd ed. Kansas City, Mo.: Technical Publications, Inc., ABCS Marine Division, 1014 Wyandotte St., 1965
McCulloch Corp.
Small Power Package. Los Angeles: Service Dept., McCulloch Corp.
-----The Two Cycle Engine. Los Angeles: Service Dept., McCulloch Corp.
Purvis, Jud.
All About Small Gas Engines. Chicago: Goodheart-Wilcox Co., Inc.,1322 South Wabash, 1963
Stephenson, George E.
Small Gasoline Engines. Albany, N.Y.: Delmar Publishing Co., 1964
Tecumseh Products Co.
Mechanics Handbook. Grafton, Wis.: Lauson-Power Products, Parts Depot Div., Form No. 690249
Vreeland, Richard C.
Customers, A Neglected Sales Force. Small Marketers Aid No. 83. Nearest SBA Office: Small Business Administration, Sept. 1962
Williams, William A.
Accident Prevention Manual for Shop Teachers. Chicago: American Technical Society. The National Association of Industrial Teacher Educators, 1963
Wisconsin Motor Corp.
Wisconsin Air Cooled Four Cylinder Engines. Milwaukee, Wis.: The Wisconsin Motors Corp.

SOURCES FOR OBTAINING MANUFACTURERS' LITERATURE

Briggs & Stratton Corp.
2711 North 13th St.
Milwaukee, Wis. 53201

Chrysler Outboard Corp.
Hartford, Wis. 53027

Clinton Engines Corp.
Maquoketa, Iowa 52060

Evinrude Motors
Service and Promotion Manager
Milwaukee, Wis. 53202

Service Promotion Manager
Johnson Motors
Waukegan, Ill. 60085

Sales Department
Engine and Electrical Plant
Kohler Co.
Kohler, Wis. 53044

Lawn-Boy Corp.
Factory Parts & Service Manager
Galesburg, Ill. 61401

Assistant Service Manager
Parts Department
Lauson Engine Division
Tecumseh Products Co.
Grafton, Wis. 53024

Field Service Manager
Engine Division
West Bend Aluminum Co.
Hartford, Wis. 53027

Sales Department
Wisconsin Motors Corp.
Milwaukee, Wis. 53246

TEACHING AIDS

Motion Pictures

CARBURETOR PRINCIPLES OF OPERATION. 25 min., b & w, Northwood Films, 926 New Jersey Ave., N.W., Washington, D. C. 20001. Summary: Explains the operation of the parts of the carburetor and theory of operation.

ONE TO A CUSTOMER. 11 min., 16mm, sd, Aetna Life Affiliated Companies, Information and Education Dept., 151 Farmington Ave., Hartford, Conn. 06115. Summary: This film attempts to instill in employees and students in shop training courses the proper attitudes toward safety aids and emphasizes the necessity of wearing protective equipment on the job.

REAMING WITH A TAPER HAND REAMER. 15 min., 16mm, b&w. The Pennsylvania State University, University Park, Pa. 16802

A SAFE SHOP. 10 min., 16mm, b&w, The Pennsylvania State University, University Park, Pennsylvania. 16802

SAFETY IN THE SHOP. 11 min., 16mm, b&w. The University of Illinois, Visual Aids Service, 704 South 6th, Champaign, Ill. 61820. Summary: Dramatizes three shop accidents, and emphasizes the teaching of safe practices and the supervisor's responsibilities.

SAY IT WITH SERVICE. 15 min., 16mm, sd, color, A.P. Parts Corp. Public Relations Manager, 1801 Spielbusch Ave., Toledo, Ohio 43601, 1963. Summary: Demonstrations of what motorists want in service. Shows best way to sell service and parts. Can be applied to small engine repair shops.

STORY OF GASOLINE. 23 min., 16mm, sd, Bureau of Mines, U. S. Dept. of Interior, Graphic Services, 4800 Forbes Ave., Pittsburg, Pa. 15213, 1958. Summary: This film, in full color, uses animation and live sequences to tell what gasoline is, how it is made, and how it acts.

USE AND CARE OF HAND FILES. 15 min., 16mm, b&w, The Pennsylvania State University, University Park, Pa. 16802

Slide Sets

From Briggs & Stratton Corp., 2711 North 13th St., Milwaukee, Wis. 53201

Slide Set No. 1, COMPLETE OVERHAUL (68 slides with instruction Manual)
Slide Set No. 3, Resizing Cylinders. (12 slides with instruction manual)

TEACHING AIDS (Continued)

Slide Set No. 4, Valve Seat Reconditioning. (12 slides with instruction manual)

No. 5, Stop, Start and Store. (25 slides with instruction manual)

7, Replacing Main Bearings. (12 slides with instruction manual)

9. Pulse Jet Carburetors. (15 slides with instruction manual)

10. Shock Free Wind Up Starter. (11 slides with instruction manual)

15. Spark Plug Cleaner. (10 slides with instruction manual)

16. Easy Spin Starting. (9 slides with instruction manual)

17. Condensers and Points. (3 slides with instruction manual)

18. Valves and Retainers. (4 slides with instruction manual)

20. Checking Carburetors. (15 slides with instruction manual)

21. New Improved Ignition Systems. (12 slides with instruction manual)

25. Sealed Starter Clutch. (10 slides with instruction manual)

From Tecumseh Products Co., Power Products Division, Grafton, Wis.53024

Slide Set No. 690141, 2-Cycle Engines. (178 slides with script)

Other

Wall Chart No. 6910102. Tecumseh Products Co.,Power Products Division, Grafton, Wis. 53024

APPENDIX A

Sample Lesson-Plan

This lesson plan is solely for use in developing an orderly approach to the presentation of this unit.

Carburetion

Unit Objective

To develop skills in dismantling, examining, adjusting, cleaning, assembling, and installing carburetors.

Time Required

Classroom, hours; laboratory, hours; shop, hours

Methods and Procedures

Present the introduction to carburetion by lecture, reading assignments, audio-visual aids, and demonstration. After the introduction, assign jobs pertaining to carburetion with the aid of job sheets.

Instructional Aids

Use films, charts, cut-a-way engines, and complete carburetors.

Relation to Prior Instruction

Relate the carburetor to the overall function of the four-stroke cycle engine.

Teaching Points

Emphasize and define the terms and components of the carburetor and their function with each other.

Check Up Questions

Schedule informal or formal tests to check students' knowledge of the subject. Review areas of weakness as shown by test results.

Laboratory Activity

Instructor will show details of three types of carburetors used on small engines. He will dismantle each type of carburetor, showing methods and procedures of detecting malfunctions. Students will examine and inspect each unit. The instructor will assemble each unit and make proper adjustments.

Shop Activity

Students will perform the following on carburetors from school-owned engines, with appropriate job sheets for each type of carburetor:

1. Become familiar with external adjustments
2. Disassemble the carburetor and outline all circuits for the instructor
3. Refer to service manual and specifications and make necessary internal inspections, measurements, and adjustments.
4. Install carburetor repair kit
5. Reassemble carburetor
6. Install carburetor on engine
7. Connect fuel lines and linkage
8. Make initial adjustments
9. Start engine using standard starting procedures
10. Make idle adjustment following manufacturers' specifications
11. Adjust high speed circuit under load

Test

Instructor will check student on each job to insure that proper procedures are being followed.

APPENDIX B

Sample Job Sheet

This sample job sheet is based on carburetion and fuel systems peculiar to the four-stroke cycle engine. A job sheet to be presented to the student after he has had an introduction to the job by lecture, discussion, and/or demonstration.

Student.....
Instructor.....
Date started.....
Date completed.....

Job

To clean and oil foam air cleaner.

Special tools, equipment, parts, and Materials

Screwdriver
Combination wrench
Approved cleaning solvent
Heavy engine oil
Parts cleaning pan
Pliers
Clean rags

Special Instructions

Prevent damage to the oil foam element. Use caution in torquing hold down bolt.

References

Operator's manual and/or service manual produced by the manufacturer for each type ofsmall gas engine.

Procedures

1. Pour approved cleaning solvent into tray on work bench
2. Clean exterior of air cleaner with a clean rag.
3. Clean inlet around carburetor opening.
4. Remove hold down bolt.
5. Remove the air cleaner cover.
6. Carefully remove the oil foam element.
7. Place element in solvent.
8. Clean air cleaner housing with a clean rag.
9. Gently squeeze excess solvent from the oil foam element.
10. Add specified amount of oil to the oil foam element.
11. Insert oil element in housing.
12. Replace housing on carburetor air horn.
13. Replace cover and insert hold down bolt.
14. Tighten hold down bolt to specified torque.

Questions:

1. Is gasoline an approved cleaning solvent?
2. What is the function of the air cleaner?
3. What are the three types of air cleaners used on small engines?
4. What effect does a plugged air filter have on engine performance?
5. What would happen if the hold down bolt was improperly torqued?
6. Why is oil used with the foam element?
7. Why is it necessary to clean the area around the air horn?

APPENDIX C

Sample Safety Test

This test consists of 10 multiple-choice questions. You are to read each question carefully. Indicate the one best answer by marking an "X" over the corresponding letter for each question on the separate answer sheet.

After you have completed the test, letter your name and other information at the top of the answer sheet. DO NOT sign your Safety Pledge until the test has been corrected and you know and understand the correct answers to all the questions missed.

1. It is always important to use tools safely because:
   a. The tools might break
   b. You might ruin your job
   c. You might cause an accident
   d. You might dull the tool
   e. All of these

2. When working around machinery, you should:
   a. Keep loose clothing tucked in
   b. Roll sleeves above the elbows
   c. Wear an apron
   d. Make adjustments when machine is stopped
   e. All of these

3. In case of an accident, whom should you notify first?
   a. Record clerk
   b. Foreman
   c. Superintendent
   d. Teacher
   e. None of these

4. The reason for placing oily rags in the safety can is to:
   a. Prevent fires
   b. Keep them off the floor
   c. Prevent bad odors in the shop
   d. Prevent the spreading of disease
   e. None of these

5. Before you can use a machine in the shop, you must:
   a. Have the power turned on
   b. Have passed the machine safety test
   c. Be dressed properly
   d. Check to see that the machine is in working order
   e. All of these

6. Who should be concerned with safety in the laboratory?
   a. The workers
   b. The safety engineer
   c. The Superintendent
   d. The Teacher
   e. All of these

7. The correct way to lift things is to:
   a. Get additional help
   b. Use your back muscles
   c. Bend back, keep knees straight
   d. None of these
8. Your sleeves should be rolled above the elbows to:
   a. Keep them clean
   b. Keep them away from work
   c. Reduce tool breakage
   d. Improve your appearance
   e. None of these
9. Scraps on the floor cause:
   a. An unsightly appearance
   b. Danger of slipping and falling
   c. More work for the cleanup group
   d. More work for the janitor
   e. All of these
10. Good safety attitudes should include:
   a. Knowing and obeying safety rules
   b. Cooperation with safety foreman
   c. Reporting any unsafe conditions
   d. Wearing suitable clothing
   e. All of these

Answer Sheet (on separate sheet)

1. A B C D E
2. A B C D E
3. A B C D E
4. A B C D E
5. A B C D E
6. A B C D E
7. A B C D E
8. A B C D E
9. A B C D E
10. A B C D E

Student's Name.....
Name of test.....
Date.....

Safety Pledge

All items in this test have been discussed by my instructor. The questions which I marked incorrectly have been reviewed by my instructor so that I fully understand the answers to all questions. I promise to observe all safety practices covered by this test.

.....
(Signature)

APPENDIX D

Sample Tests

Tests are administered for various reasons and must be developed by each individual instructor.

Samples of written test questions based on carburetion peculiar to the four-stroke cycle engine appear below.

Completion Type

1. How is the choke valve operated?
2. Where is the governor spring located?
3. What happens if the governor spring is distorted?
4. Where is the high speed adjustment located?
5. What is the proper factory high speed adjustment setting?
6. Where is the low speed or idle adjustment located?
7. What is the initial setting of the low speed adjustment?
8. What type of float is used?
9. Why is a clean air cleaner so important to proper air-fuel ratios?
10. What would happen to the air-fuel mixture if the air cleaner became restricted?

True or False

True	False		
....	....	1.	Up draft, down draft, and side draft are three types of carburetors used on small engines.
....	....	2.	A float level is checked by using a feeler gauge
....	....	3.	A venturi is a funnel-shaped unit
....	....	4.	The function of a venturi is to break up fuel into fine particles
....	....	5.	The circuits of a small engine carburetor are choke, pressure, and low speed
....	....	6.	The fuel tank is vented because atmospheric pressure is needed on the fuel
....	....	7.	The proper air-fuel ratio is approximately 12:1.
....	....	8.	A balanced type carburetor is used on all small engines
....	....	9.	A choke valve is operated by vacuum and heat
....	....	10.	The governor spring is located inside the flywheel

APPENDIX E

Sample Progress Chart

A progress chart serves to provide a readily available check on the progress of individual students. Progress charts serve as a motivation device to the student because he can measure his progress compared to that of his fellow students.

When a student is assigned a job, a diagonal line is drawn in the proper box. When the job has been satisfactorily completed, an "X" is placed in the appropriate box by adding the opposing diagonal line.

A portion of a progress chart is shown on this page. This may be used as a guide for the instructor as he develops his progress chart. The chart may be developed in any size.

Unit: Carburetion four-cycle Student	Service in line fuel filter	Service dry type air filter	Service oil bath air filter	Overhaul gravity feed carb.	Overhaul suction feed carb	Overhaul diaphragm type carb
Anderson, C. E.						
Bakken, O. D.						
Horton, J. S.						
Johnson, L. V.						
Neperus, T. A.						
Olson, A.						
Shuett, W. E.						
Williams, W. W.						